NASA CR-166737

PRINCETON UNIVERSITY OBSERVATORY
Princeton, New Jersey

SEC SENSOR PARAMETRIC TEST AND EVALUATION SYSTEM

(NASA-CR-166737) SEC SENSOR PARAMETRIC TEST AND EVALUATION SYSTEM Final Report, 29 Apr. 1976 - 29 Jan. 1977 (Princeton Univ., N. J.) 175 p HC A08/MF A01 CSCL 14B

N82-10381

Unclas
G3/35 39423

FINAL REPORT – CONTRACT NAS 5-23386
Prepared For
National Aeronautics And Space Administration
Goddard Space Flight Center
Greenbelt, Maryland

March 7, 1978

FINAL REPORT ON CONTRACT NAS5-23386

SEC Sensor Parametric Test and Evaluation System

Princeton University
Department of Astrophysical Sciences
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March 7, 1978

Final Report, April 29, 1976 to January 29, 1977

Prepared for

GODDARD SPACE FLIGHT CENTER

Greenbelt, Maryland 20771

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle Final Report on Contract NAS5-23386 SEC Sensor Parametric Test and Evaluation System.	5. Report Date July 19, 1977
	6. Performing Organization Code
7. Author(s) Princeton University Observatory	8. Performing Organization Report No.
9. Performing Organization Name and Address Princeton University Dept. of Astrophysical Sciences Princeton, N.J. 08540	10. Work Unit No.
	11. Contract or Grant No. NAS5-23386
12. Sponsoring Agency Name and Address Goddard Space Flight Center Greenbelt, Maryland 20771 Attn: Dr. Tom Kelsall	13. Type of Report and Period Covered FINAL REPORT April 29, 1976 to January 29, 1977
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

On April 29, 1976 Princeton University received contract NAS5-23386 for the design, fabrication and testing of a Parametric Test and Evaluation System to be developed in support of the SEC Sensor Development Program. This system provides the necessary automated hardware required to carry out, in conjunction with the existing 70-mm SEC television Camera built under NGR 31-001-236 and NAS 5-20833, the sensor evaluation tests detailed in Appendix A of the Statement of Work for this contract.

The Parametric Test Set (PTS) has been completed and is being used in a semi-automatic data acquisition and control mode to test the development of the 70-mm SEC sensor, WX 32193. Data analysis of raw data is being performed on the Princeton IBM 360-91 computer.

17. Key Words (Selected by Author(s))	18. Distribution Statement
SEC Sensor Parametric Test Set	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
None	None	173	

*For sale by the National Technical Information Service, Springfield, Virginia 22151.

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SECTION 10 SUMMARY

On April 29, 1976 Princeton University received contract NAS5-23386 for the design, fabrication and testing of a Parametric Test and Evaluation System to be developed in support of the SEC Sensor Development Program. This system provides the necessary automated hardware required to carry out, in conjunction with the existing 70-mm SEC[1] Television Camera built under NGR 31-001-236 and NAS 5-20833, the sensor evaluation tests detailed in Section 110.

The Parametric Test Set (PTS) has been completed and is being used in a semi-automatic data acquisition and control mode to test the development of the 70-mm SEC sensor, WX 32193 (see Figures 31-33 which are photographs of the PTS). Data analysis of raw data is being performed on the Princeton IBM 360-91 computer.

This final report includes the system block diagrams and general description of system operation, as well as an introduction to the SEC sensor. A full, hard-copy set of the manufacturing drawings along with the purchased subsystem operation and maintenance manuals are kept with the PTS. Microfiche copies of these documents have been submitted to NASA.

[1] The 70-mm dimension refers to the diagonal dimension of the target, which is a rectangular structure 50.6 mm x 55.6 mm.

SECTION 20 Statement of Design Requirements and Purpose

The basic program requirement was to design and to fabricate all the components needed to transform the existing manually-operated, laboratory 70-mm SEC TV camera into a complete sensor testing system. The goal was to develop a sensor Parametric Test Set (PTS) that would operate in a semi-automatic data acquisition and control mode, and be capable of performing exhaustive 70-mm SEC sensor tests. (See Appendix A of the Work Statement, Section 131.) In accomplishing this task, Princeton drew on its experience in modifying the 35-mm Observing Camera to provide direct digital recording of TV data. In addition, the PTS program benefitted from the engineering design work performed in the parallel program to build the 70-mm Observing Camera (OBSCAM) under the Goddard Space Flight Center (GSFC) contract NAS 5-22989.

To operate in a semi-automatic data acquisition and control mode, it is necessary for the PTS to perform several functions:

1. To control the prepare, expose, and read cycles of the camera electronics;
2. To digitize and store the target video signal as it is read from the camera, preferably at the maximum rate permitted by the hardware;
3. To display, upon operator request, stored data-frames, parts of frames, and single lines.

Tasks 2 and 3 require a fast mass storage medium capable of direct access -a magnetic disc. Further, as large quantities of data must be stored for later analysis, either on-line at the PTS or by a different computer, a fourth function arises:

4. To copy data back and forth between the disc and magnetic tape.

As these tasks place different demands upon the system, it is possible to increase throughput by doing more than one of them at a time. For example, Task 1 must be performed without interruption (in "real time"), but it requires relatively little input-output (i.e., transfers of data between memory and the

camera) and few memory cycles. Task 4, on the other hand, is a succession of high-volume data transfers which is insensitive to interruption. As long as Task 1 is given a higher priority than Task 4 (so that Task 1 interrupts Task 4 and not vice versa) the two can be performed simultaneously. This multi-tasking capability is possessed by the PTS.

SECTION 30 Description of the Parametric Test Set

As the PTS is the result of modifications to the manually operated 70-mm SEC tube test set, it is convenient to view the PTS as a combination of two integral units: (1) the tube test set; and, (2) the 7/32 computer with its associated hard-core software. When these two units are combined into a single system, they provide the capability of operating in a semi-automatic data acquisition and control mode. Together they PREPARE, EXPOSE, and READOUT the target of the 70-mm SEC sensor being evaluated.

The tube test set is a combination of four subsystems, which are:

1. The Camera Electronics Rack: contains the slow scan TV monitor, oscilloscope, video system, sync-generator, manual control panel, and the D/A and A/D converters. (Figure 31).
2. Camera Head: contains the deflection yoke, magnetic focus coil, wide and narrow band preamplifiers and SEC sensor (Figure 32).
3. Head Accessory Rack: contains the photocathode high voltage supply, deflection power amplifiers, and the cooling control electronics. (Figure 33).
4. Optical Image projection is provided by a Test Pattern and Light Source Projector designed and fabricated by Ball Brothers Research Corporation. (Figure 32).

Together these subsystems form the basic system for operation in manual mode, and when coupled with the 7/32 computer in a semi-automatic mode.

Semi-automatic data acquisition and operation of the camera electronics is provided by the 7/32 computer. Referring to Figure 33, included in this system are:

1. Interdata 7/32 processor with 32 registers, each 32 bits wide in two stacks of sixteen.
2. Pertec tape drive and formatter. 9 track 1600 BPI.
3. Pertec Disc. 10^6 bytes.
4. Datamedia CRT terminal.

In addition to these listed units, it was necessary to design and fabricate interface electronics designated Universal Logic Interface (U.L.I. #1 and U.L.I. #2) Analog to Digital (A/D) and Digital to Analog (D/A) converters. To accommodate the computer it was also required to modify some of the existing circuit cards in the tube test set.

Referring to Figure 34, the Camera Head includes two independent pre-amplifiers: (1) a narrow band pre-amplifier bandwith (BW) = 80 kHz, but which can also be used at BW's of 20 and 40 kHz (40 kHz is "normal"), (2) wide band pre-amplifier, BW = 800 kHz. Pre-amplifier selection is achieved by computer commands via the Datamedia CRT terminal when the PTS is under computer control, or manually by selecting the proper Address and Value command (refer to section 80 and Table 84) then actuating the Manual Load pushbutton. Optical focus is optimized by moving the sensor and focus coil assembly on a worm gear mechanism driven by a 12 Volt dc Globe motor controlled by a toggle switch located on the Camera Electronics Rack. A micro switch in the head assembly protects against mechanical overtravel of the focus mechanism. The deflection coil assembly, including the alignment coils, were made by Celco Engineering, Mahwah, N.J., Coil No. B-1868-101.

The Head Accessory Rack houses the Celco Deflection Amplifier (No. DAPD4N-5) used to drive the deflection coils, the ± 35V power supplies for the amplifier, and the electronics required to interface the amplifier and the deflection coils. Also included in the accessory rack is the electronics

required to control the LN_2 boiling rate and monitor the temperature near the sensor's photocathode. Cooling to -20°C is obtained by boiling LN_2 in a dewar and passing the gas over the sensor's photocathode. When the desired temperature has been reached (sensed by a calibrated diode located near the photocathode), boiling of the LN_2 (via resistors located inside the dewar) is stopped. Regulation to within 1°C of the desired temperature is achieved by cycling power to the resistors thus controlling the flow of LN_2 gas.

The Camera Electronics Rack contains the slow scan TV monitor, oscilloscope, three sub-chassis (designated 100, 200, 300) and power supplies. Refer to the PTS manufacturing drawings for a description of circuit cards located in chassis No. 100, 200, and 300. The 7/32 computer and its associated hardware are housed in two racks. One contains the Pertec tape drive and formatter and the Interdata 7/32 processor. The second rack contains the Pertec Disc.

The Camera Control Front Panel (Figure 35) mounted in the Camera Electronics Rack contains four functional areas:

1) Computer or manual control selection with manual address, value, and load inputs; 2) Line selection, which is used to display select video information on oscilloscope and monitor during live camera operation (see Section 103, note 32 for line selection from the disc); 3) Master reset, which is used to reset the camera functions to their safe, standby values; and 4) Light emitting diodes (LED) displays used to indicate the camera's status.

The selection of the computer or manual control is performed by selecting the position of the <u>Command Mode</u> toggle switch to either the <u>Computer</u> or <u>Manual</u> position. When in the <u>Manual</u> position, the camera's functional storage latches may be changed by loading the appropriate address and value information into the Command Address and Command Value digiswitch[1] and depressing the <u>Enter Data</u> pushbutton switch.

During live camera operation when the output from the target is not being digitized, what video information is displayed on the oscilloscope and monitor

1. See Section 80.

may be selected by the line selection function. Only the n^{th} line, every n^{th} line, or every line of a frame may be displayed by depressing the appropriate pushbutton of the multi-station switch labeled One, Multi, or Full. The Line Select digiswitch allows the selection of the appropriate n^{th} line. The line selection function drives the horizontal triggering of the oscilloscope and intensifies that particular line, or lines, on the monitor.

The reset of the camera's functional storage latches (that control electrode voltages, read beam, etc.) to their safe, standby values, is actuated by depressing the Reset pushbutton (Refer to Table 84).

The LED displays on the Control Panel give data on the following. The top four LEDs indicate when the camera is reading a frame of video in the readout mode (Readout), when the camera video is being digitized (Direct Dig.), when the camera is in the continuous scan mode (CSN)[1], or when the camera is in an exposure mode (Expose). The next ten rows of LEDs displays the camera functional status, which include the status of the Heater, scan Rate, scan Size, Target voltage, Mesh and PC[3] voltages, Beam current, Erase Lite LED current,[2] Shutter (command is available, but not presently used), and LED Light source (contained in the Test Pattern and Light Source Projector). The next two rows of LEDs indicate the value of the selected video Bandwidth and Gain. The Digitizer/ Display Mode row of LEDs indicate if video is being digitized normally, in the burst mode (See Section 60), or if the computer is playing back video via the D/A. CL/DISAB is a computer initiated command that ends the Digitizing or Playback mode. The TEST light is activated when the computer commands are given by manual operation at the circuit board level during test. The

---

1. In this mode the electron beam readout is continuous without interruption by the erase and prepare cycle.
2. Erase lights are mounted in a circle foreward of the photocathode behind the lens.
3. Photocathodes.

Preamp row of LEDs indicates which preamplifier is active and processing video from the SEC. The Beam Mode LEDs display the type of readout scanning beam used in the SEC.

The system software is basically a two-task operation running under OS/32-MT (Interdata's 32-bit multi-tasking operating system). These tasks are designated:

CC - Camera Control Task. An interpreter which accepts, as input, commands in a simple and intuitive camera control language and translates them into signals for operating the camera. Commands may be read individually from the console or from sequences stored in disc files.

DA - Data Task. Transfer data among the camera, disc files, magnetic tape, and play back equipment; builds header records and keeps a printed log of digitized exposures; controls the camera electronics during digitization. The playback facilities of this task enable the operator to examine single lines, groups of lines, and whole frames.

Both tasks control the camera via the Universal Logic Interface cards.

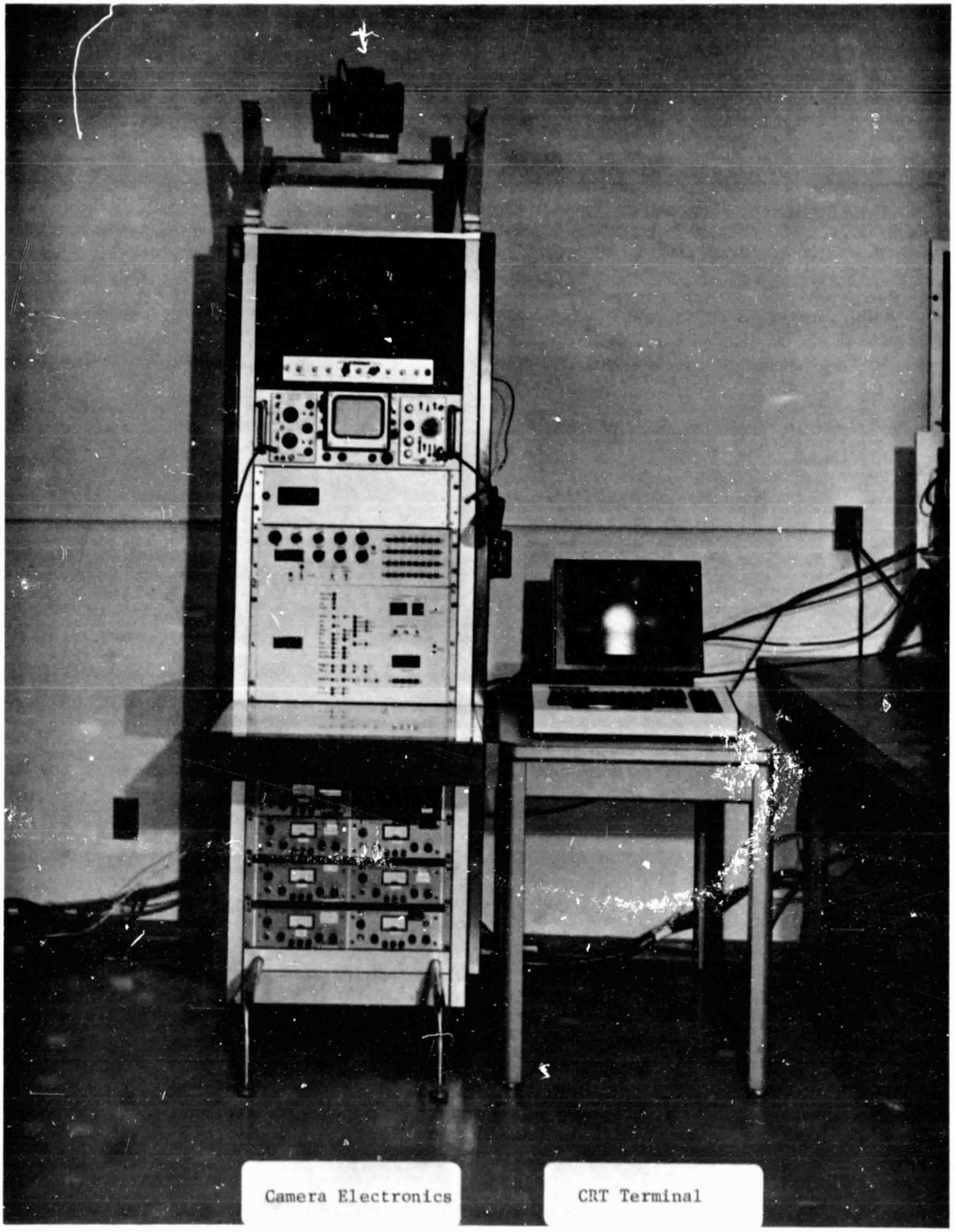


Figure 31 - PTS Camera Electronics with CRT Terminal.

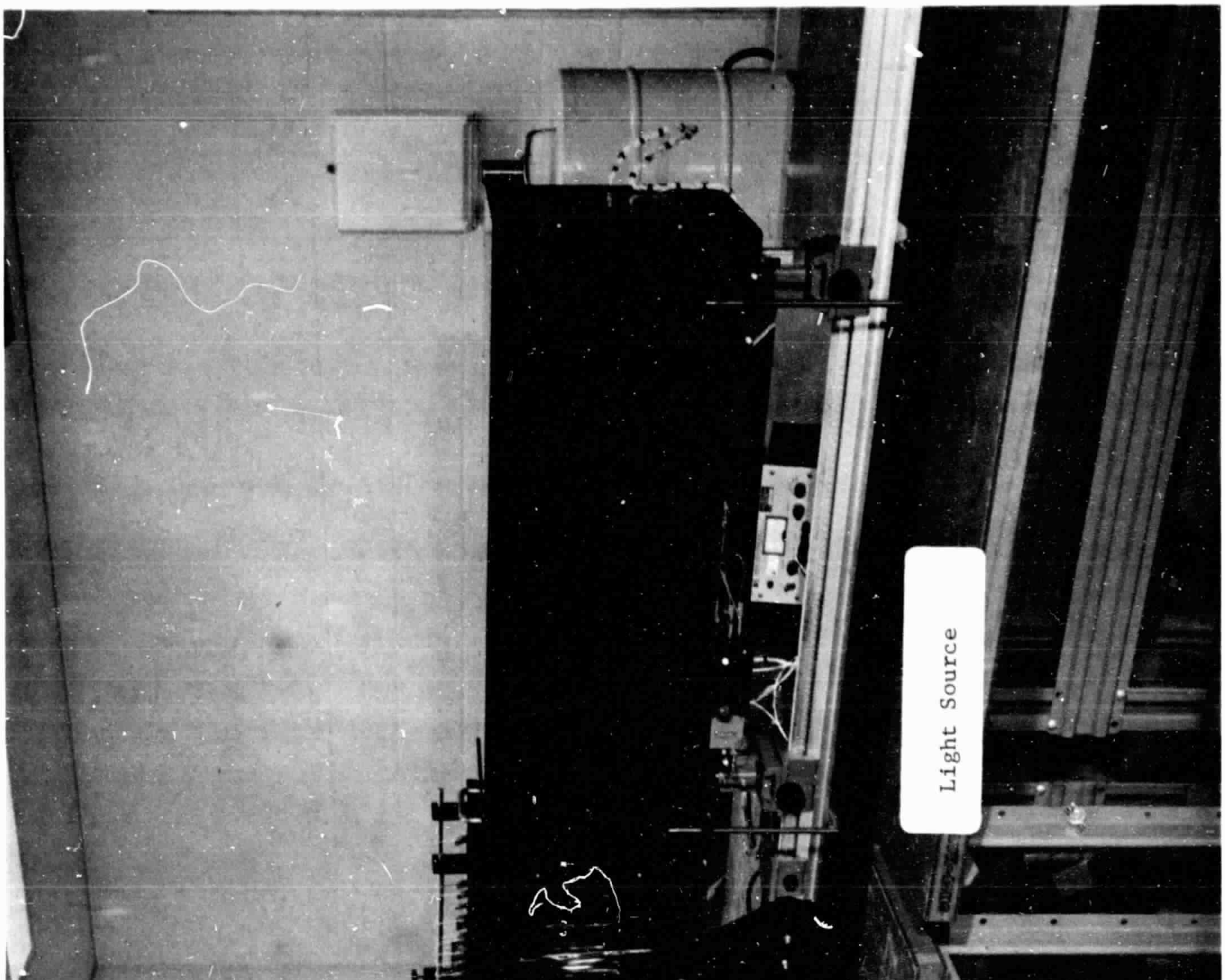


Figure 32 - PTS Light Source and Image Projector, and also the 70mm Camera Head.

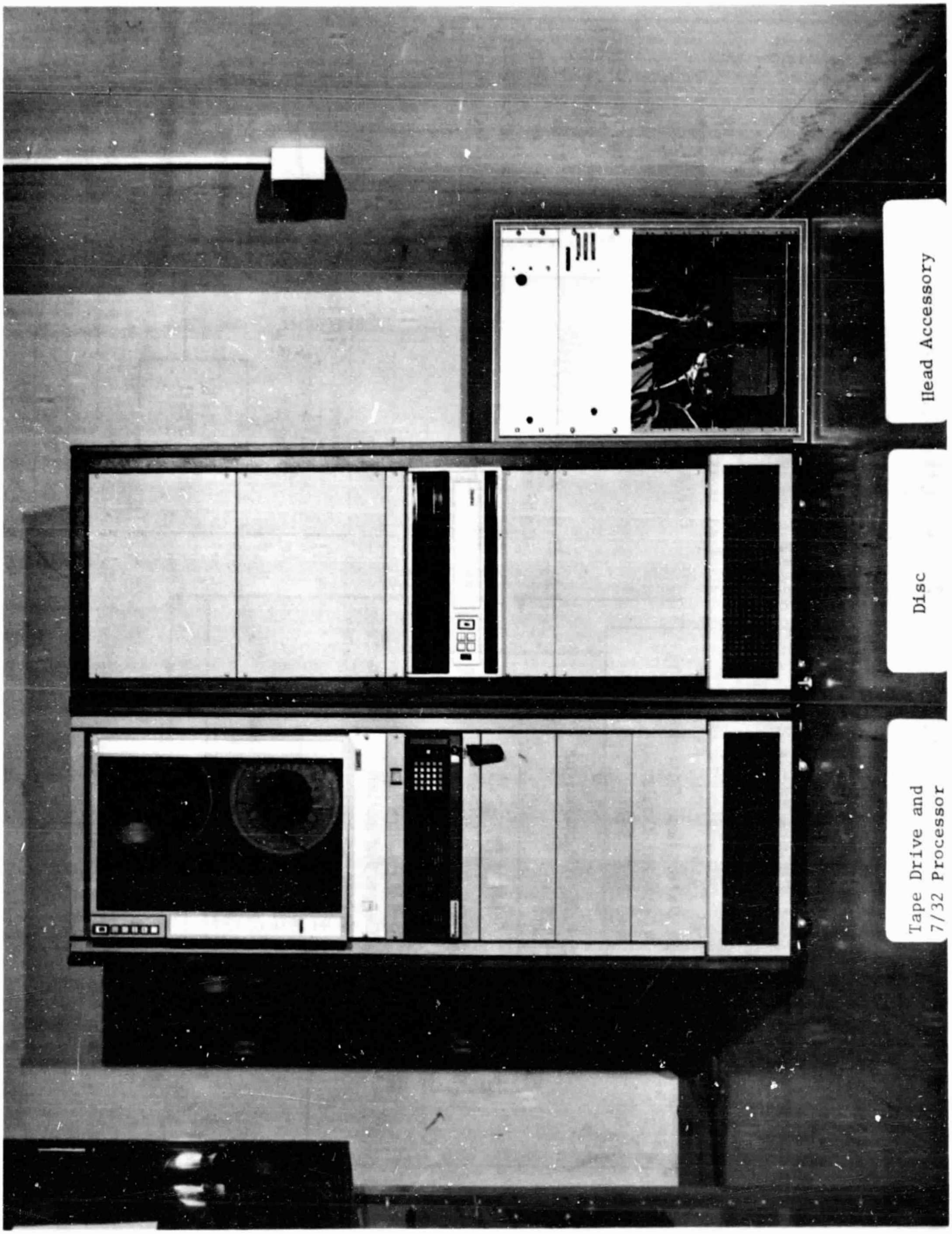
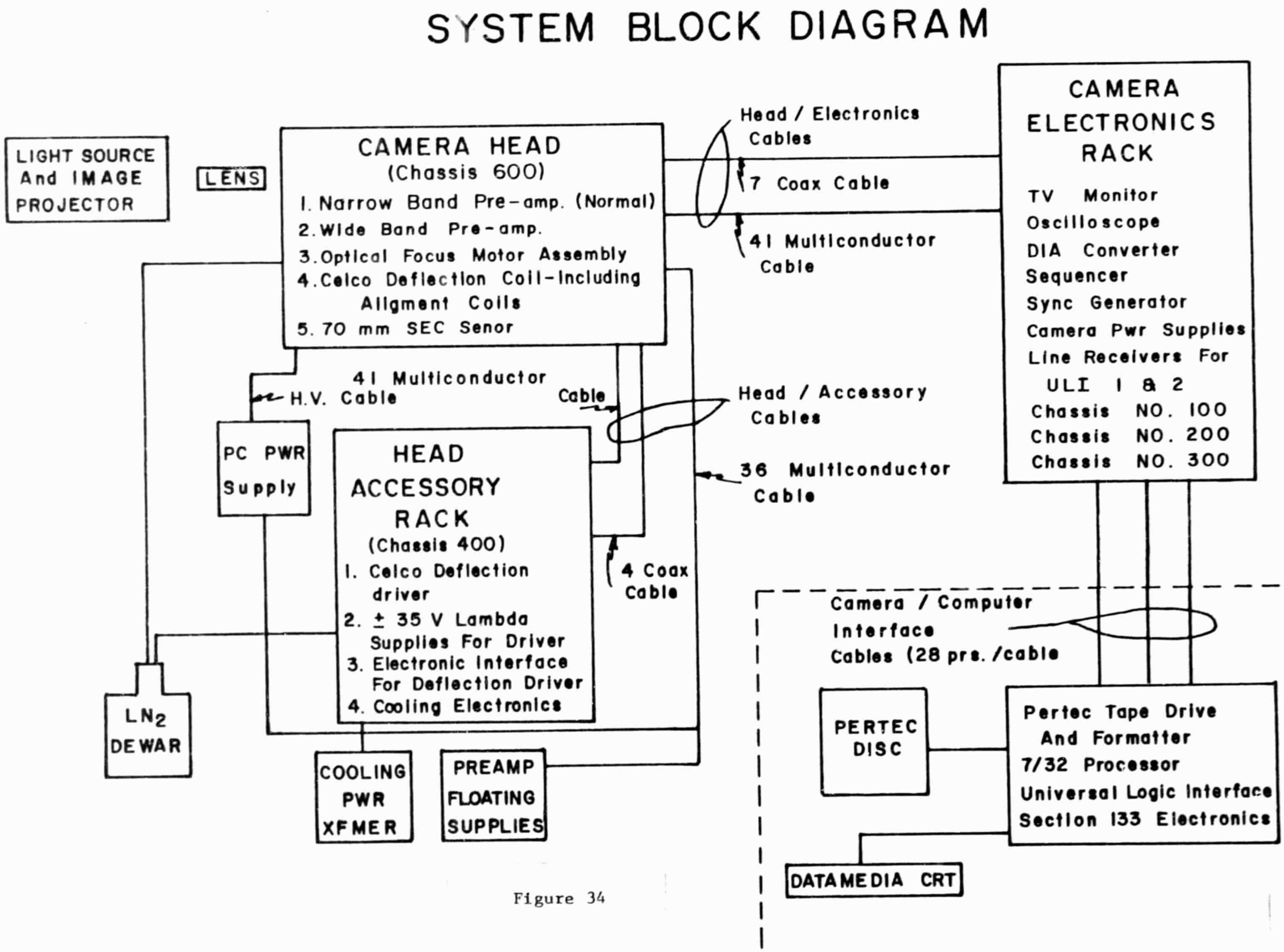


Figure 33 - The Computer Hardware and Auxiliary Electronics.



SYSTEM BLOCK DIAGRAM
LIGHT SOURCE And IMAGE PROJECTOR
LENS
CAMERA HEAD
(Chassis 600)
1. Narrow Band Pre-amp. (Normal)
2. Wide Band Pre-amp.
3. Optical Focus Motor Assembly
4. Celco Deflection Coil-Including Allgment Coils
5. 70 mm SEC Senor
Head / Electronics Cables
7 Coax Cable
41 Multiconductor Cable
CAMERA ELECTRONICS RACK
TV Monitor
Oscilloscope
DIA Converter
Sequencer
Sync Generator
Camera Pwr Supplies
Line Receivers For
ULI 1 & 2
Chassis NO. 100
Chassis NO. 200
Chassis NO. 300
41 Multiconductor
H.V. Cable
Cable
Head / Accessory Cables
PC PWR Supply
HEAD ACCESSORY RACK
(Chassis 400)
1. Celco Deflection driver
2. ± 35 V Lambda Supplies For Driver
3. Electronic Interface For Deflection Driver
4. Cooling Electronics
36 Multiconductor Cable
4 Coax Cable
Camera / Computer Interface Cables (28 prs. /cable
LN2 DEWAR
COOLING PWR XFMER
PREAMP FLOATING SUPPLIES
PERTEC DISC
Pertec Tape Drive And Formatter
7/32 Processor
Universal Logic Interface
Section 133 Electronics
DATAMEDIA CRT

Figure 34

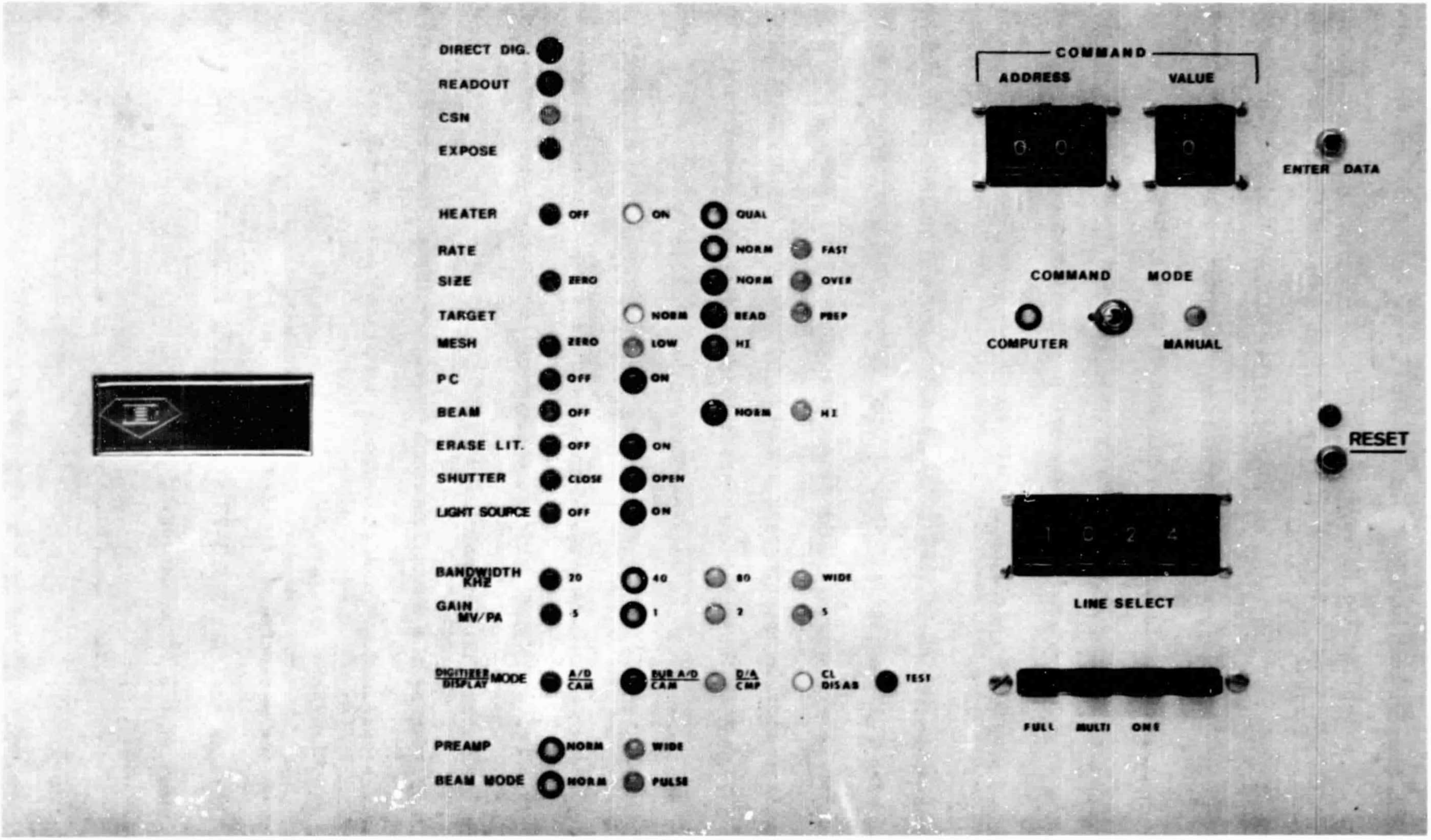


Figure 35

Camera Control Front Panel

SECTION 40 SEC SENSOR

In the mid-60's NASA recognized that television type sensors would be very useful in space astronomy if they could be made to integrate for long periods of time, provide high spatial resolution, and achieve high photometric precision without excessive sensor cooling. A study completed in 1965 concluded that a magnetically focused SEC sensor made by Westinghouse had the best chance of meeting these requirements. This choice was based on the almost indefinite storage capability of the SEC's potassium chloride target which also exhibited a gain of approximately 100 to overcome readout noise.

Through a series of SR&T grants and contracts a magnetically focused SEC sensor with a 35 mm diagonal (25 x 25 mm) format was developed for scientific photometric applications. This sensor was flown in a Princeton sounding rocket ultraviolet echelle spectrograph payload and was used for a number of ground based astronomical observations (see bibliography). It is currently being used as the data sensor in the Balloon Ultraviolet Stellar Spectrograph, (BUSS), a collaborative program between the Space Research Laboratory at Utrecht, Netherlands and the NASA Johnson Space Center. This 35 mm SEC sensor is also the data sensor for the NCAR-High Altitude Observatory's Coronograph/Polarimeter for the Solar Maximum Mission satellite.

Anticipating the Space Telescope requirements, a 70 mm version of this sensor was designed. The most recently completed development was sponsored under the GSFC/NASA contract NAS 5-20833, "Large, High Resolution Integrating TV Sensor for Astronomical Applications."[1] At the present time, Princeton, under the GSFC/NASA contract NAS 5-23387, is working to improve and to standardize the design of the 70 mm sensor.

SECTION 41 SEC Sensor Principles of Operation

The SEC type television camera sensor has been described in detail in the literature.[2,3] It is similar to the earlier television camera sensors such as the Image Orthicon in its exposure mechanism and to the Vidicon in its readout mechanism.[4] The electron bombarded silicon target sensors (EBS), also referred to as SIT sensors, are similar in their principle of operation to the SEC sensor.

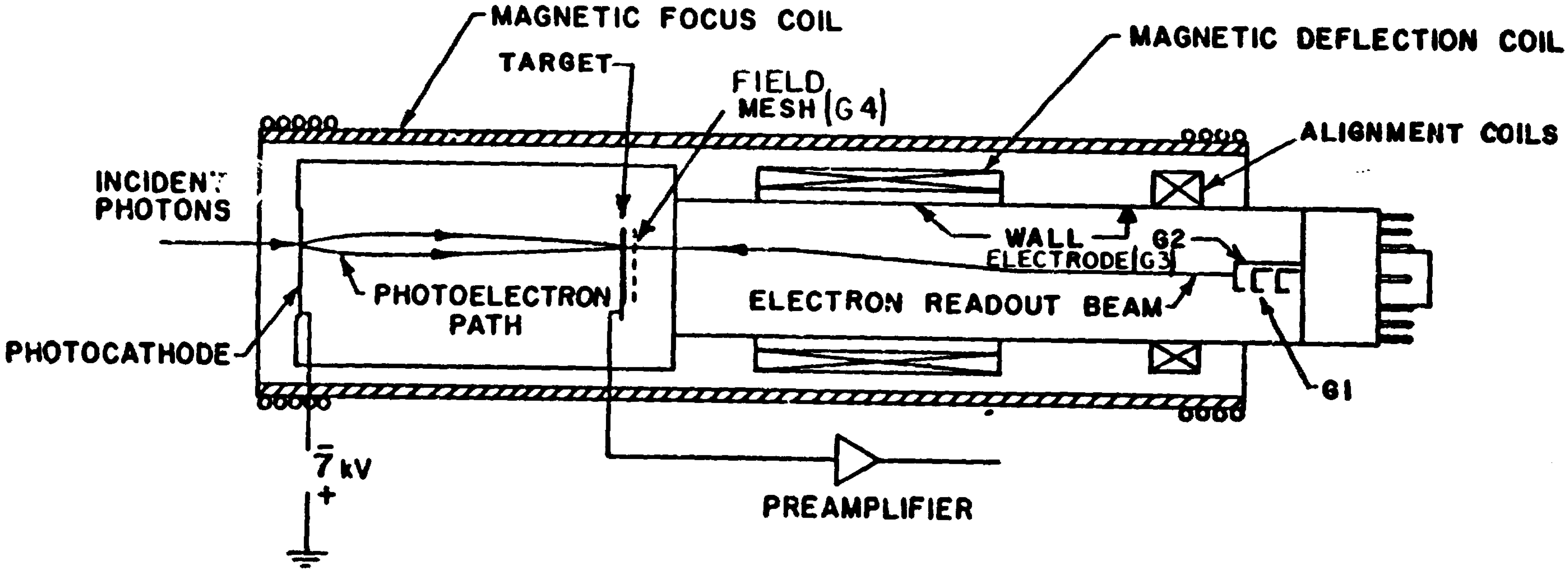
In the SEC, referring to Figure 41, photons are absorbed in a photocathode evaporated on the vacuum side of the window (in this case magnesium fluoride). Photoelectrons emitted from the photocathode are accelerated by an 7000 volt electrostatic field, created by eight ring electrodes in the image section. The photoelectrons then strike the target, also shown in Figure 41. An axial 80 gauss magnetic field focuses the photoelectrons at the target in one Larmor loop. At the target a small percentage of the photoelectrons are backscattered or absorbed in the Al_2O_3 supporting substrate and the aluminum signal plate. After losing approximately 2000 volts getting through the Al_2O_3 and Al layers, the photoelectrons pass into a low density (~1%), potassium chloride layer. Here they lose a large fraction of their energy creating secondary electrons, then pass through the KCl layer into the vacuum and strike the mesh or gun electrodes. Prior to the exposure to the photoelectrons the vacuum side of the low density KCℓ layer is polarized negatively with respect to the conductive signal plate by scanning it with a low energy electron beam while a positive potential is applied to the signal plate. Therefore, the secondary electrons created by the photoelectrons move to the signal plate leaving a positive charge near the vacuum side of the KCℓ layer. This results in a charge pattern on the target that is the analog of the integrated optical image on the photocathode.

The electronic image is read out by slowly scanning (frame time << std. TV rate) the target with a finely focused low energy electron beam. Electrons are deposited on the target as the KCℓ is restored by the scanning beam to a uniform voltage potential over its surface. The electron signal flowing to the signal plate during readout is about 70 times the integrated photoelectron input to the target due to the multiplying action of the secondary emission process within the KCℓ layer. This "video" signal is amplified by a low noise amplifier. It should be noted that before a second exposure of high quality can be made after reading out an image, it is necessary for the target to be "prepared" by scrubbing it clear of all residual image.

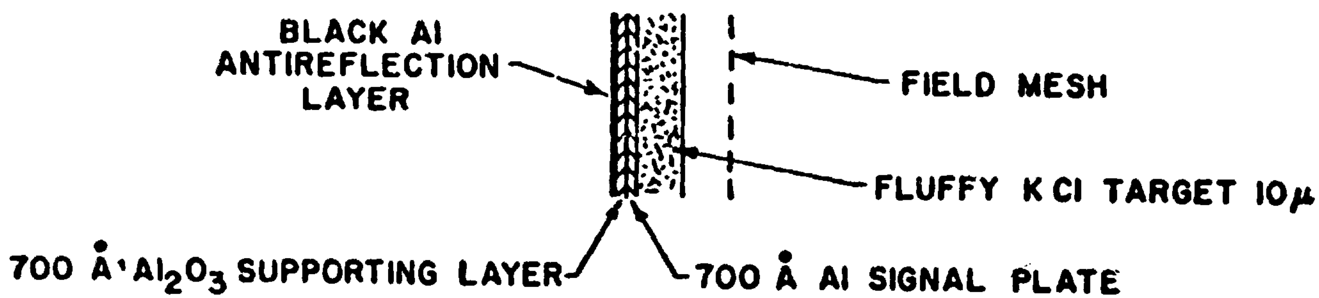
In the 70 mm SEC sensor the vacuum surface of the KCℓ is coated with a very thin layer of gold evaporated at a shallow angle to the surface. This layer serves to reduce any secondary emission created by the electron beam scanning of the KCℓ during readout. This gold coating eliminates the need of the usual suppressor mesh found in SEC sensors designed to operate at standard TV rates.

Figure 42 shows a detailed drawing of the SEC as of June 1976. Figure 43 is a photograph of a 70 mm SEC.

WESTINGHOUSE WX 32193 SEC TUBE



TARGET STRUCTURE



WX-32193 IMAGE TUBE DESIGN

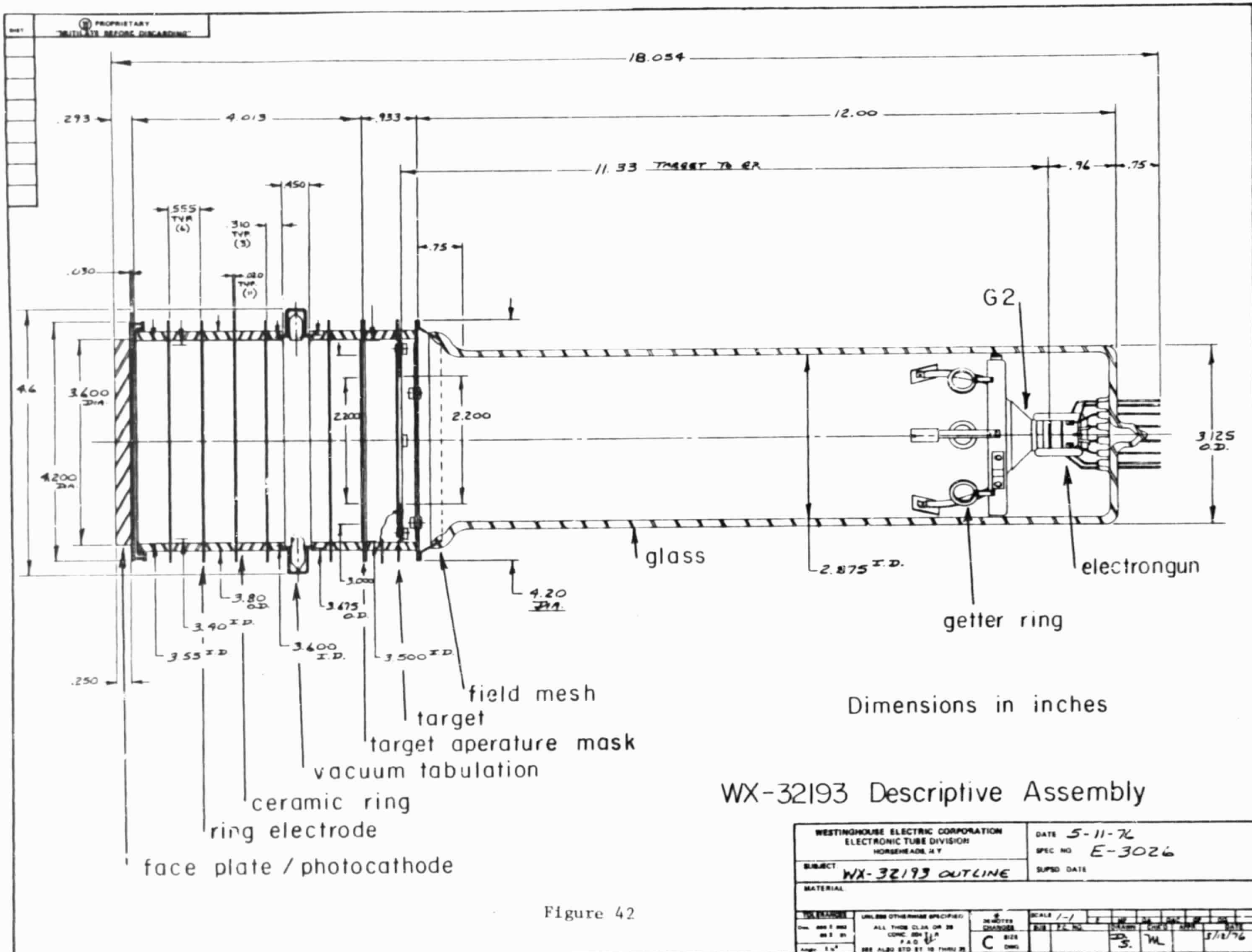


Figure 42

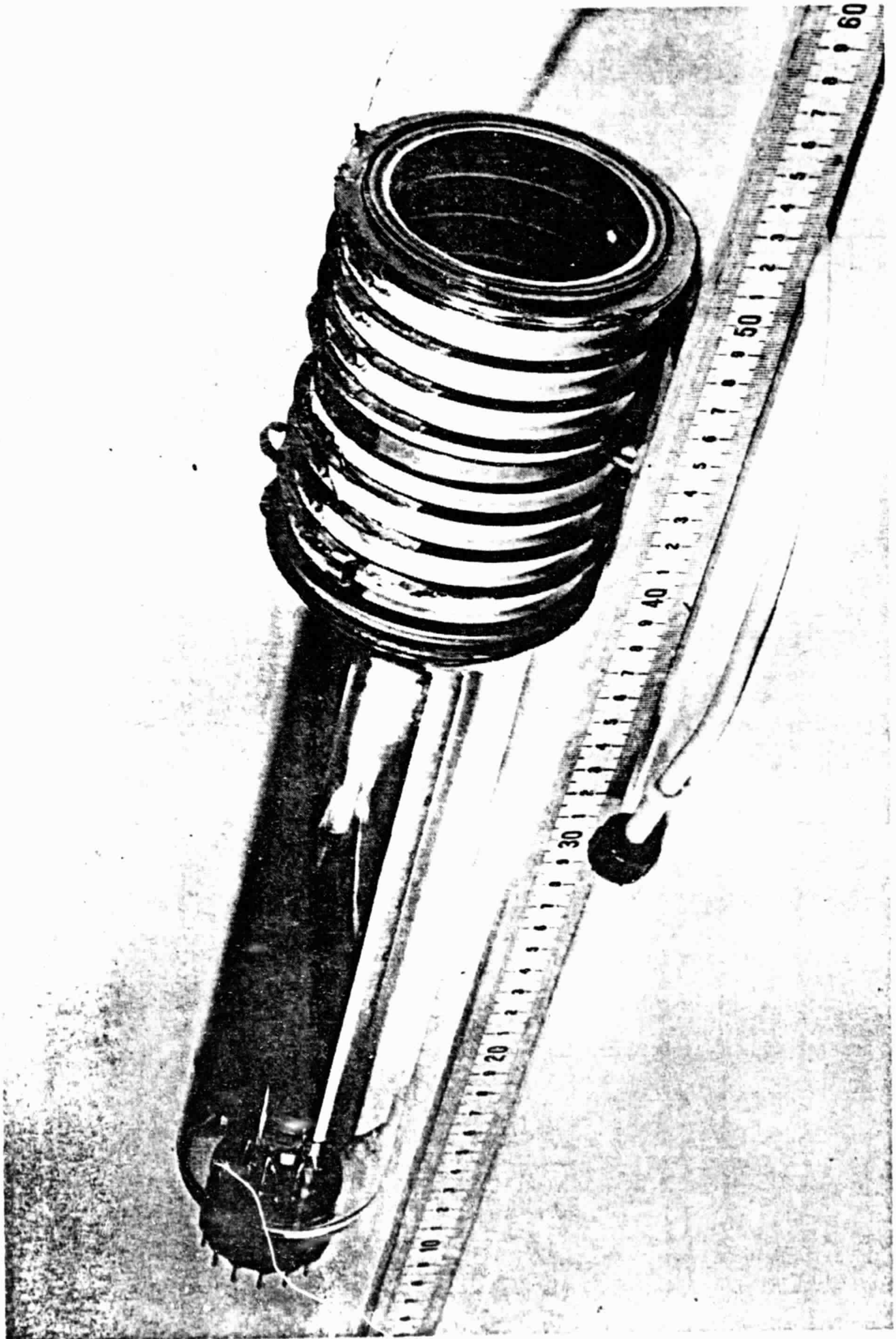


Figure 43 Westinghouse WX-32193, 70 mm SEC SENSOR

SECTION 42 Typical Operating Conditions

For the most demanding photometric applications, it is necessary to operate the SEC sensors in a slow scan readout mode. The reason for this is that the noise contributed by a preamplifier that is optimized for the best noise performance decreases as the scan rate is decreased. That is, the longer the preamplifier is allowed to examine the readout charge from each pixel the more accurate the charge measurement will be.

This noise reduction as the scan rate is reduced does not continue indefinitely. Below about 20 kHz analog bandwidth (25 microsecond sample time = 25 μ pixel) there is no further improvement (at least with present amplifiers and SEC tubes) and the noise performance actually degrades at still slower readout rates. In fact, there is a broad valley of optimum pixel readout times ranging from 50 to 5 microseconds per pixel.

The present Princeton equipment for SEC sensor testing and for astronomical observing with SEC's, operates at a pixel readout period of 14 microseconds per pixel, which is equivalent to an analog data bandwidth of 36 kHz. It requires 68 seconds to readout a 70 mm SEC target at that scan rate. In order to expedite sensor and equipment adjustments the PTS includes a fast scan mode where the sample is one microsecond per pixel (500 kHz analog bandwidth, five second frame time). Although the threshold performance is degraded, the ability to examine the output at the faster frame rate permits rapid assessment of general sensor performance and determination of iterative adjustments to optical and image section focus.

Table 41 lists the actual slow scan operating conditions for a representative 70 mm SEC sensor.

TABLE 41

TYPICAL OPERATING PARAMETERS FOR A 70-mm SEC SENSOR

Actuals for Sensor W 31 (Serial No. 77-21-919)[1]

PC	(photocathode, image section focus)	5850	V.
V_t	(target)	15	V.
Wall	(beam focus electrode, G3)	913	V.
Mesh	(G4 electrode, field mesh)	923	V.
IG2	(G2 current, ≈ total electron gun current)	30µ	A.
G1	(electron gun bias)	-107	V.
G2	(electron gun anode)	299	V.
I_f	(focus coil current)	.7168	A.
I_h	(electron gun heater current)	157m	A.
V_h	(electron gun heater voltage)	6.3	V.
IAB	(beam alignment current, coil A)	-12m	A.
IAB	(beam alignment current, coil B)	-12m	A.

Note: 1. Voltages measured with respect to the electron gun cathode.

SECTION 50 Light Source and Test Pattern Projector

The optical image focussed on the photocathode is produced using the Light Source and Test Pattern Projector, which is lens coupled to the SEC. The projector contains 3 sets of LED's (20 each of red, yellow, green LED's) and an incandescent bulb. These light sources illuminate a diffuser, which acts as a uniform background for a test pattern negative.

The Light Source and Test Pattern Projector was designed and fabricated by Ball Brothers Research Corporation. See Figure 51 for a mechanical sketch of the projector, and Figure 52 for a schematic and a mechanical layout of the Light Emitting Diode (LED) sources. Any one of four light sources can be used to illuminate a diffuse screen:

1.	Red	660 ± 30 nm
2.	Yellow	590 ± 35 nm
3.	Green	565 ± 35 nm
4.	White Light	(incandescent)

The internal walls between the light source and the diffusion glass are covered with highly polished stainless steel. Uniformity is ± 2% over a 23 cm square area. (See Section 134 for specifications and uniformity measurements.)

Master negatives for the light source are produced on the Princeton film scanner at 3 x linear magnification of the SEC format size. A computer program, CHART, prepares a digital tape for programming the film scanner. From the master CHART negatives, very high contrast contact prints are made which then serve as the actual test pattern used for tube testing. A Schneider Componon, f/5.6, 135 mm enlarging lens, operating at 3:1 demagnification, is used to project the test pattern onto the tube.

Figure 53 is a block diagram of the light source controller. This circuit, along with the manual selector and intensity control, is mechanically attached to one side of the light projector (see Figure 51). The intensity control sets

the reference used in the closed loop control of the LED sources. The incandescent white light source is operated open loop. Regulation is achieved by chopping the LED diodes ON for 3.9 msec and OFF for 190 μsec. During the OFF period the FET switch opens and the integrator holds the last LED ON value, and the Silicon Photo Detector (SPD) dark current is measured and stored in the clamp. This measured dark current is subtracted by the clamp circuit. During the LED ON time, the feedback action forces the clamp output to equal the reference.

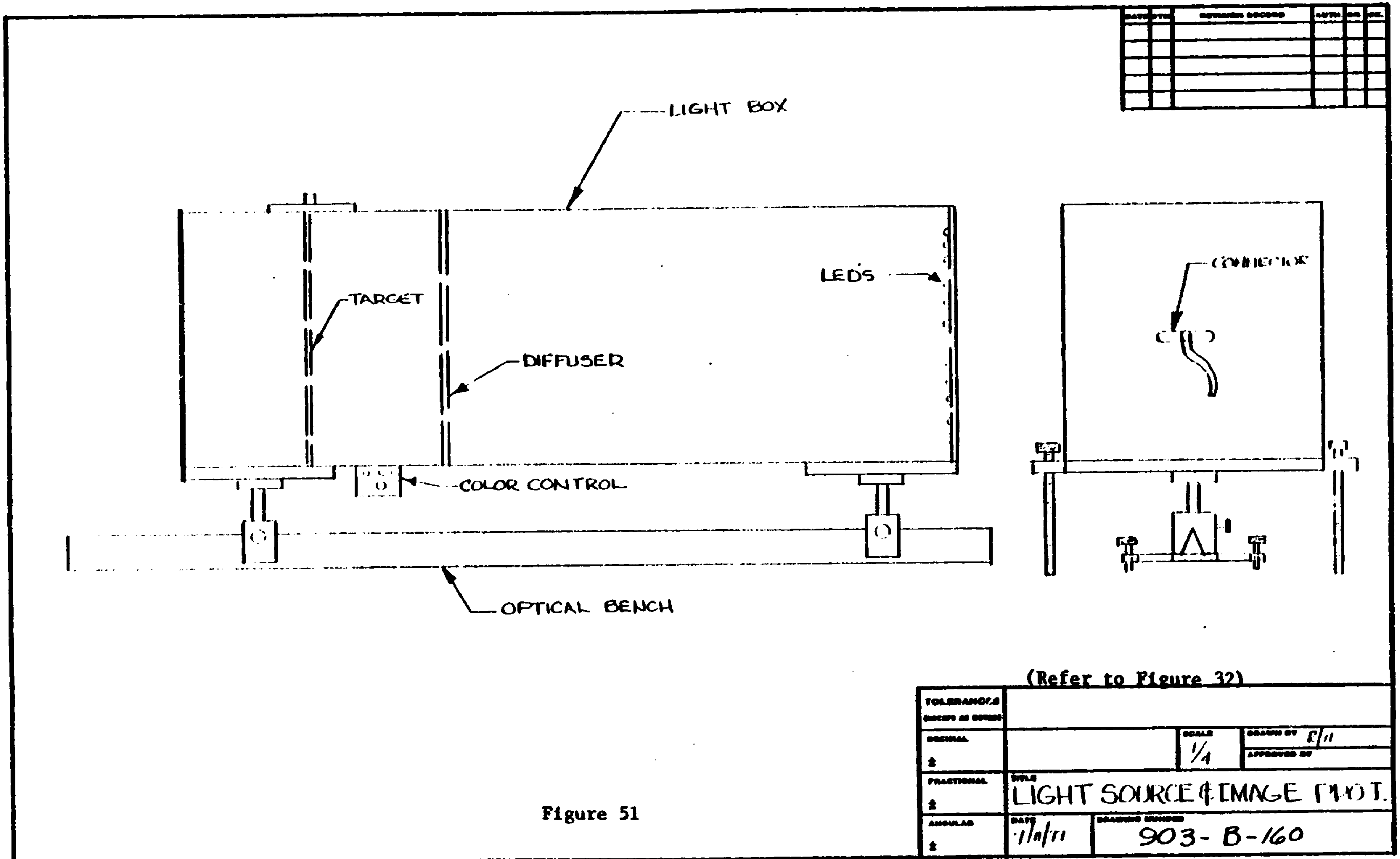
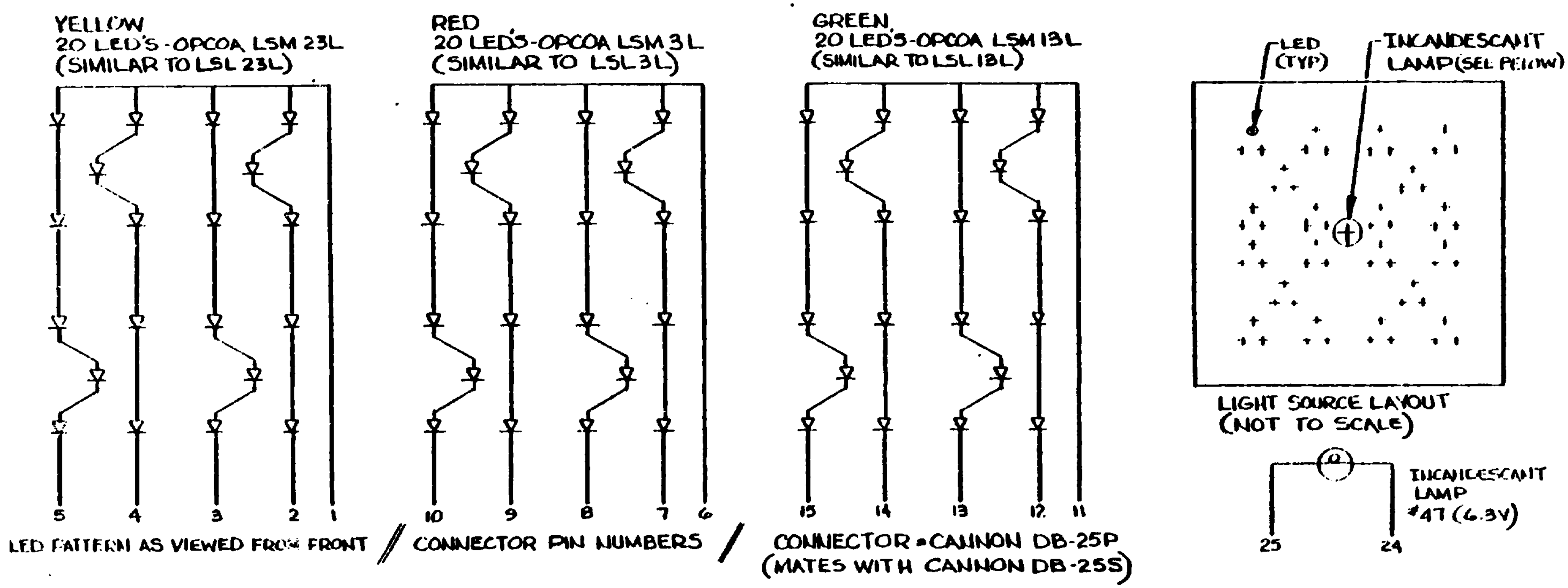

LIGHT BOX
LEDS
TARGET
DIFFUSER
COLOR CONTROL
OPTICAL BENCH
(Refer to Figure 32)
TOLERANCES
DECIMAL
FRACTIONAL
ANGULAR
SCALE
1/4
TITLE
LIGHT SOURCE & IMAGE PLOT.
DRAWING NUMBER
903- B-160

Figure 51

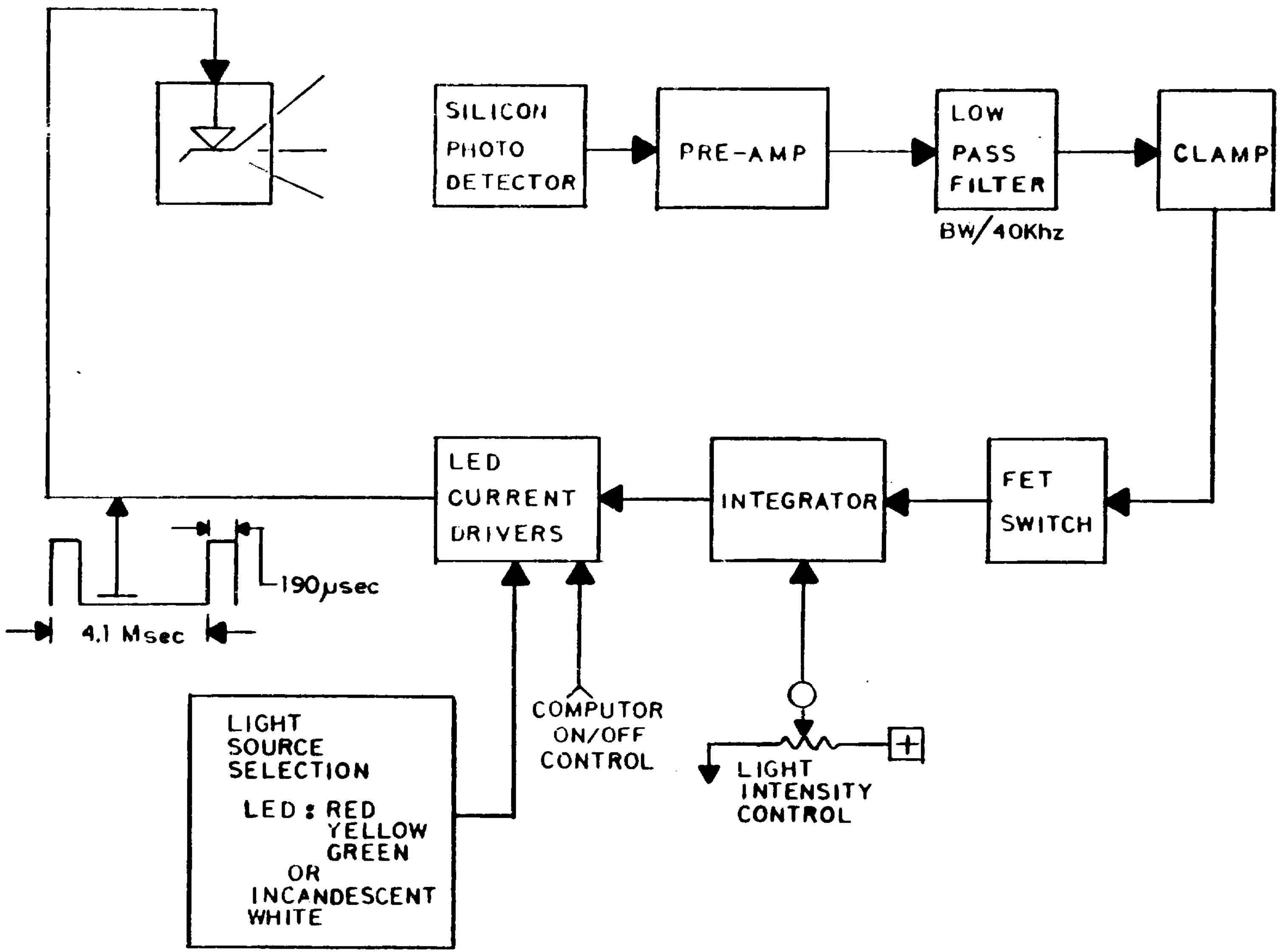


NOTES:

1. DWG NO: REF BALL BROTHERS #53794 & #53320
2. NEXT HIGHER ASSY-BALL BROTHERS #53671

Figure 52

TOLERANCES (EXCEPT AS NOTED)			
DECIMAL ±		SCALE NONE	DRAWN BY R H / APPROVED BY
FRACTIONAL ±	TITLE SCHEMATIC, PRINCETON LIGHT BOX		
ANGULAR ±	DATE 12/21/:	DRAWING NUMBER SEE NOTE 1	



LIGHT SOURCE CONTROL BLOCK DIAGRAM

Figure 53

SECTION 60 Video Processing

Video data in the PTS is processed in two forms, analog and digital as shown in Figure 61. The analog video signal current from the SEC target is processed for visual display on the slow scan monitor and quick look data measurement on the oscilloscope. This analog video data is converted to digital form for recording in temporary form on a disc. It is then transferred onto magnetic tape for use in subsequent, later computer analysis. The PTS includes two modes of digitizing, NORMAL and BURST.

In the NORMAL digitization mode the center 51.2 mm of each TV scan line on the SEC target is divided into 2048 25 micron pixels, with each pixel's analog video level being encoded as a 12 bit binary digital word. (Refer to Section 70 for image format details.) Because the computer world is organized to handle data in eight, sixteen, and thirty-two bit binary words, each pixel's encoded intensity is treated as the 12 least significant bits of a 16 bit word.

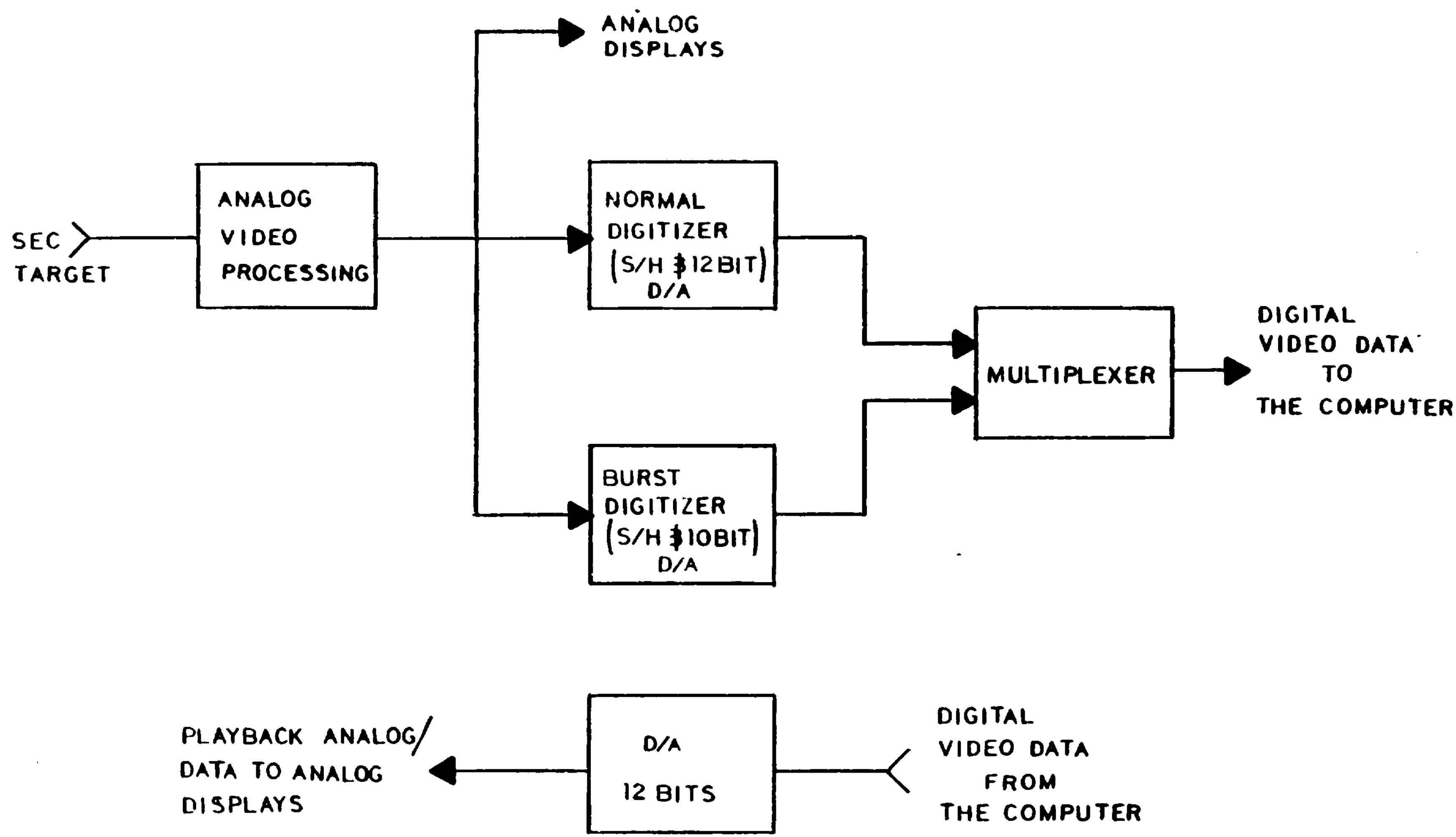
The BURST mode digitizer is a tool for studying the resolution of the SEC sensor in detail. While the NORMAL mode digitizer samples each of the 2048 25μ pixels on each TV line once, the BURST mode digitizer provides seven (7) equally spaced samples in a 25μ pixel. This increased sample density permits the clear reconstruction of analog video waveform details down to the single pixel level. However, there are inherent trade-offs made when using in the BURST mode. The most significant trade-off is that the BURST mode consumes storage space for the digital data words at seven times the normal rate. Accordingly, it is not practical to digitize an entire TV line at the BURST mode density. As one-seventh of the TV line at the BURST rate produces the same number of samples as a full (51.2 mm, 2048 pixels) length TV line at normal rates, only a selected one-seventh segment of a line can be digitized

and stored in the BURST mode. However, the PTS operator has full control over what portion of the line is digitized. The second trade-off is that the BURST digitizer only encodes the video signal to 10 bit precision. This is of little practical consequence as the 12 bit encoding used in the NORMAL mode is really quite conservative and 10 bit encoding is sufficiently precise for all but the extreme limits of the dynamic range of the best SEC targets currently expected.

Figure 62 details the analog processing circuits which are located in both the Camera Head Electronics and in the main Electronics rack. Preamplifier bandwidth is an operator selectable parameter (see Table 84).

Also included is a developmental method for spectrally separating video image data from the microphonics. Separation is accomplished by putting the data on a carrier by modulating or chopping the readout beam at a rate of two beam-on pulses per pixel. That spectrally separates the data from the microphonic signals. Then the data is recovered via a synchronous demodulator after band-pass filtering which rejects the microphonic signals. This method is completely successful at microphonic rejection but results in degradation of preamplifier noise performance.

Figures 63 and 64 are detailed block diagrams of the analog-to-digital (A/D) and digital-to-analog (D/A) portions of the PTS video data subsystem.



BLOCK DIAGRAM PTS VIDEO PROCESSING

Figure 61

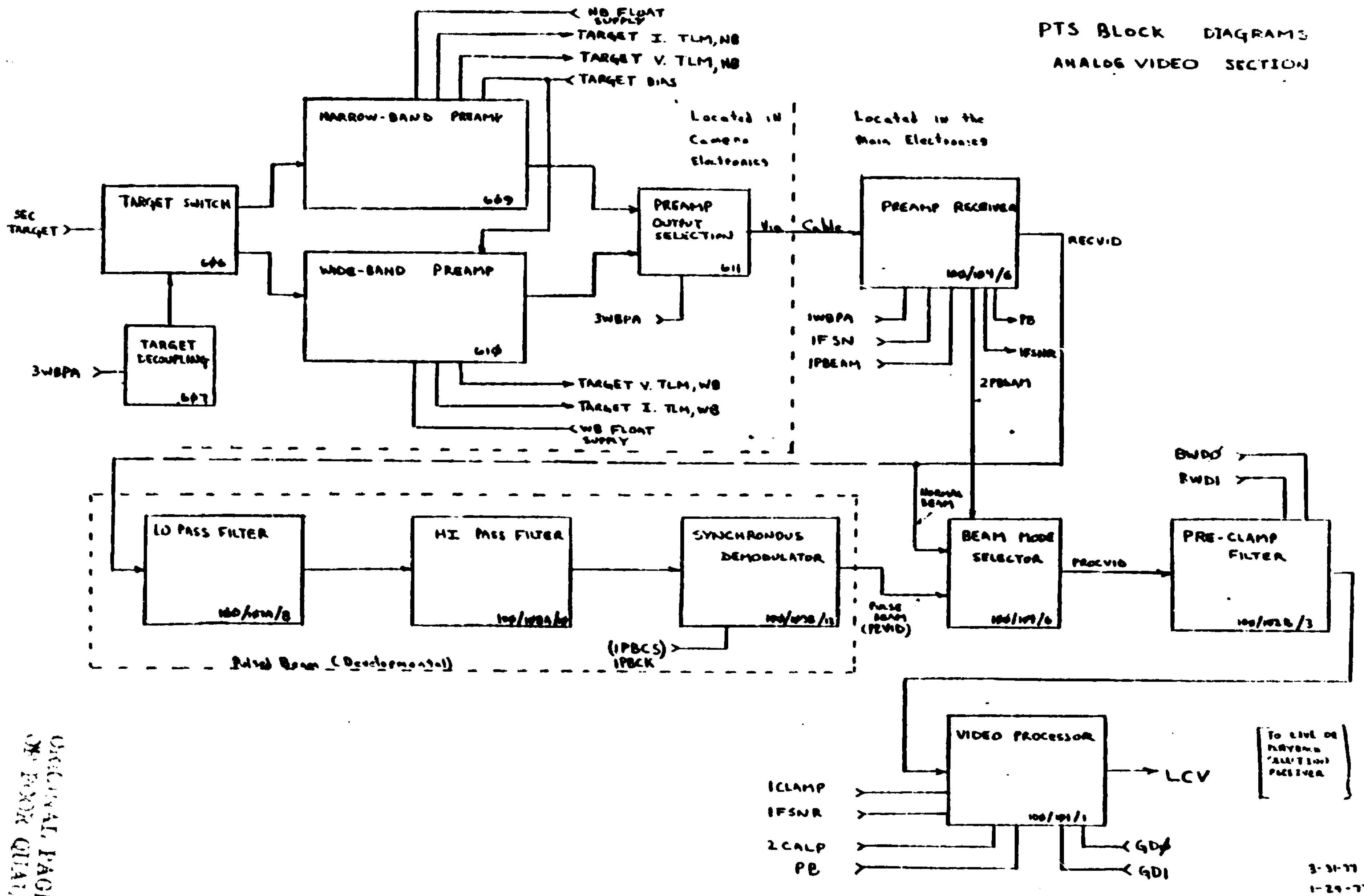

PTS BLOCK DIAGRAMS
ANALOG VIDEO SECTION
NARROW-BAND PREAMP
WIDE-BAND PREAMP
TARGET SWITCH
TARGET DECOUPLING
PREAMP OUTPUT SELECTION
PREAMP RECEIVER
BEAM MODE SELECTOR
PRE-CLAMP FILTER
VIDEO PROCESSOR
LO PASS FILTER
HI PASS FILTER
SYNCHRONOUS DEMODULATOR
NB FLOAT SUPPLY
TARGET I. TLM, NB
TARGET V. TLM, NB
TARGET BIAS
TARGET V. TLM, WB
TARGET I. TLM, WB
WB FLOAT SUPPLY
SEC TARGET
3WBPA
Located in Camera Electronics
Located in the Main Electronics
Via Cable
RECVID
1WBPA
IFSN
1PBEAM
PB
2PBEAM
NORMAL BEAM
PULSE BEAM (PBVID)
PROCVID
BWDO
RWDI
(IPBCS)
IPBCK
Pulsed Beam (Developmental)
LCV
ICLAMP
IFSNR
2CALP
PB
GDØ
GDI
3-31-77
1-24-77

Figure 62

PTS BLOCK DIAGRAMS

VIDEO ANALOG to DIGITAL Section

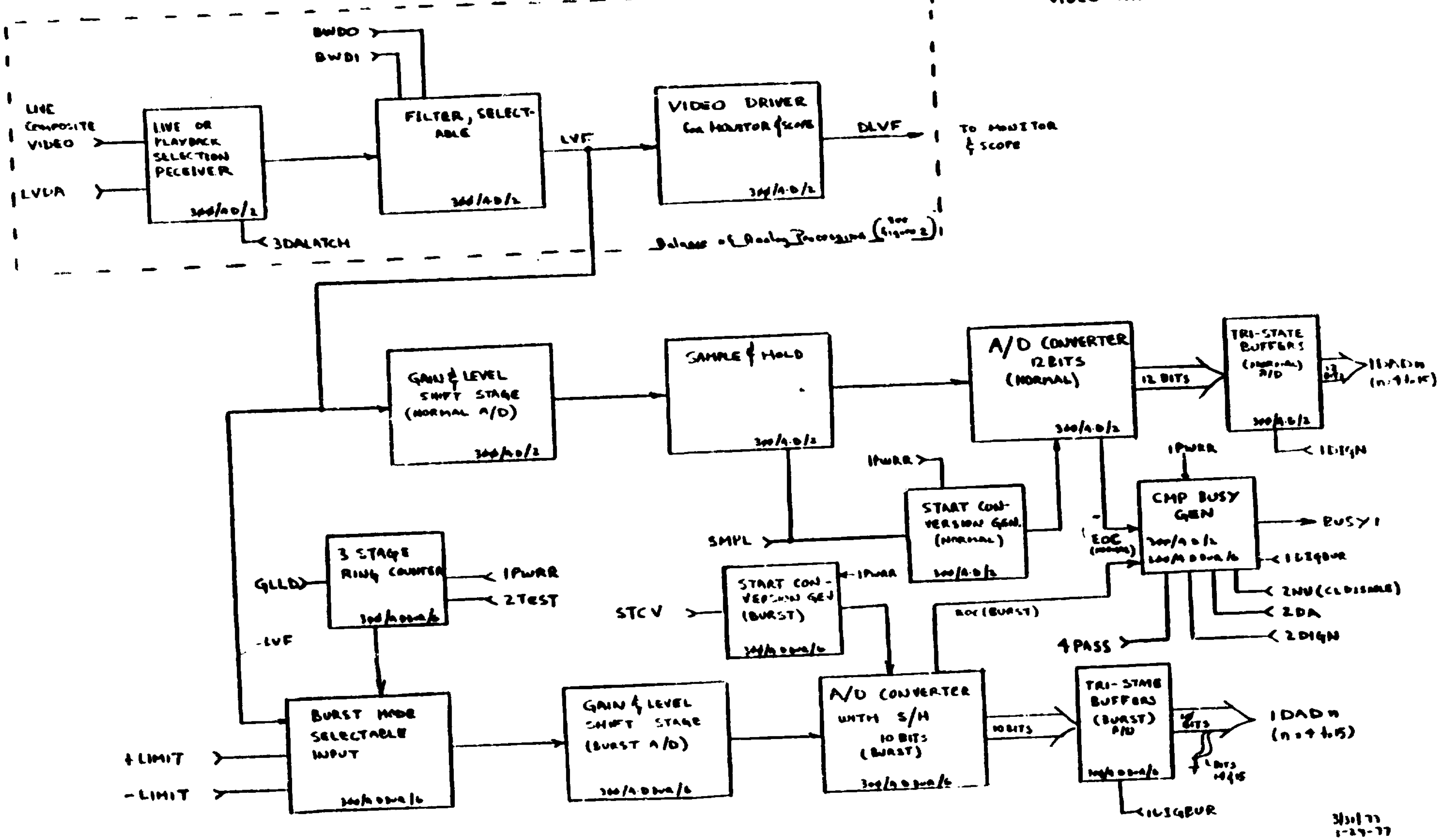


Figure 63

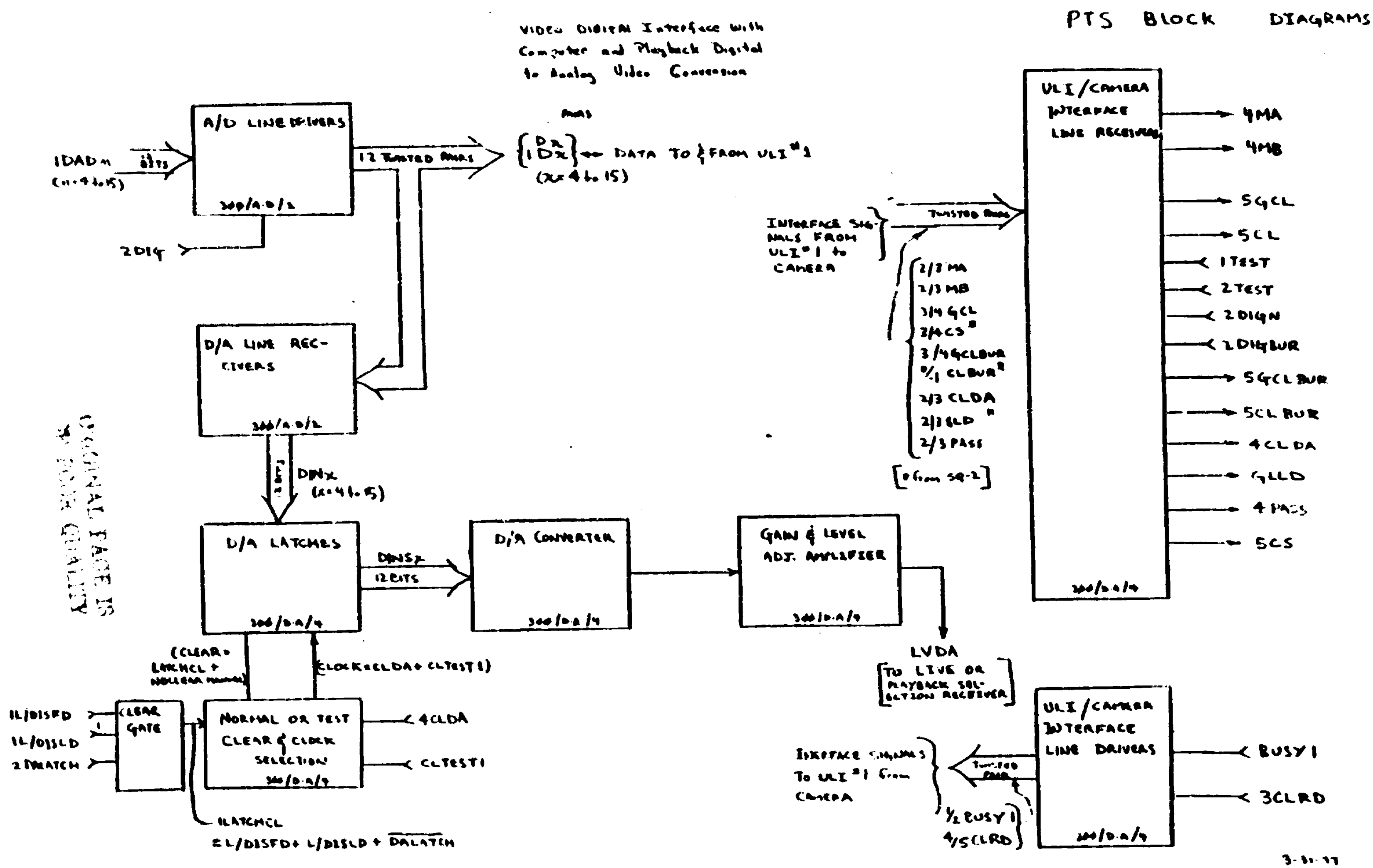

PTS BLOCK DIAGRAMS
VIDEO DIGITAL Interface with Computer and Playback Digital to Analog Video Conversion
A/D LINE DRIVERS
1DADn
12 TWISTED PAIRS
DATA TO & FROM ULI #1
(x=4 to 15)
2DIG
D/A LINE RECEIVERS
DINx
D/A LATCHES
12 BITS
D/A CONVERTER
GAIN & LEVEL ADJ. AMPLIFIER
LVDA
TO LIVE OR PLAYBACK SELECTION RECEIVER
CLEAR GATE
NORMAL OR TEST CLEAR & CLOCK SELECTION
4CLDA
CLTEST1
1L/DISFD
1L/DISLD
2DLATCH
ULI/CAMERA INTERFACE LINE RECEIVERS
4MA
4MB
5GCL
5CL
1TEST
2TEST
2DIGN
2DIGBUR
5GCLBUR
5CLBUR
4CLDA
4PASS
5CS
INTERFACE SIGNALS FROM ULI #1 to CAMERA
TWISTED PAIRS
2/3 MA
2/3 MB
3/4 GCL
2/3 CLDA
2/3 PASS
ULI/CAMERA INTERFACE LINE DRIVERS
BUSY1
3CLRD
INTERFACE SIGNALS To ULI #1 from CAMERA
1/2 BUSY1
4/5CLRD
3-31-77
1-24-77

Figure 64

SECTION 70 Image Format and Related Electronics (Sync Generator)

Sync generation for the PTS is detailed in Figures 71 and 72. "Sync Generator" is the TV term for that portion of the electronics that provides the digital timing signals needed to define the scan line and pixel structure of the readout image raster or format. The basic clock is a 2 mHz crystal oscillator. Two readout scan rates are provided, nominally referred to as Fast and Normal. The Fast scan rate reads the entire SEC target in just under 5 seconds. This rate is convenient for initial alignment and "quick look" operation of the SEC tube. It is not suitable for quantitative data recording, primarily because the electronic noise level is too high at the wide bandwidths associated with the fast scan rate. The Normal scan rate reads a full data frame in about 68 seconds. Fast or Normal timing is determined by programming the rate selector and line drive clock generator. The start of a line scan is phase locked with the mean phase of the power line waveform.

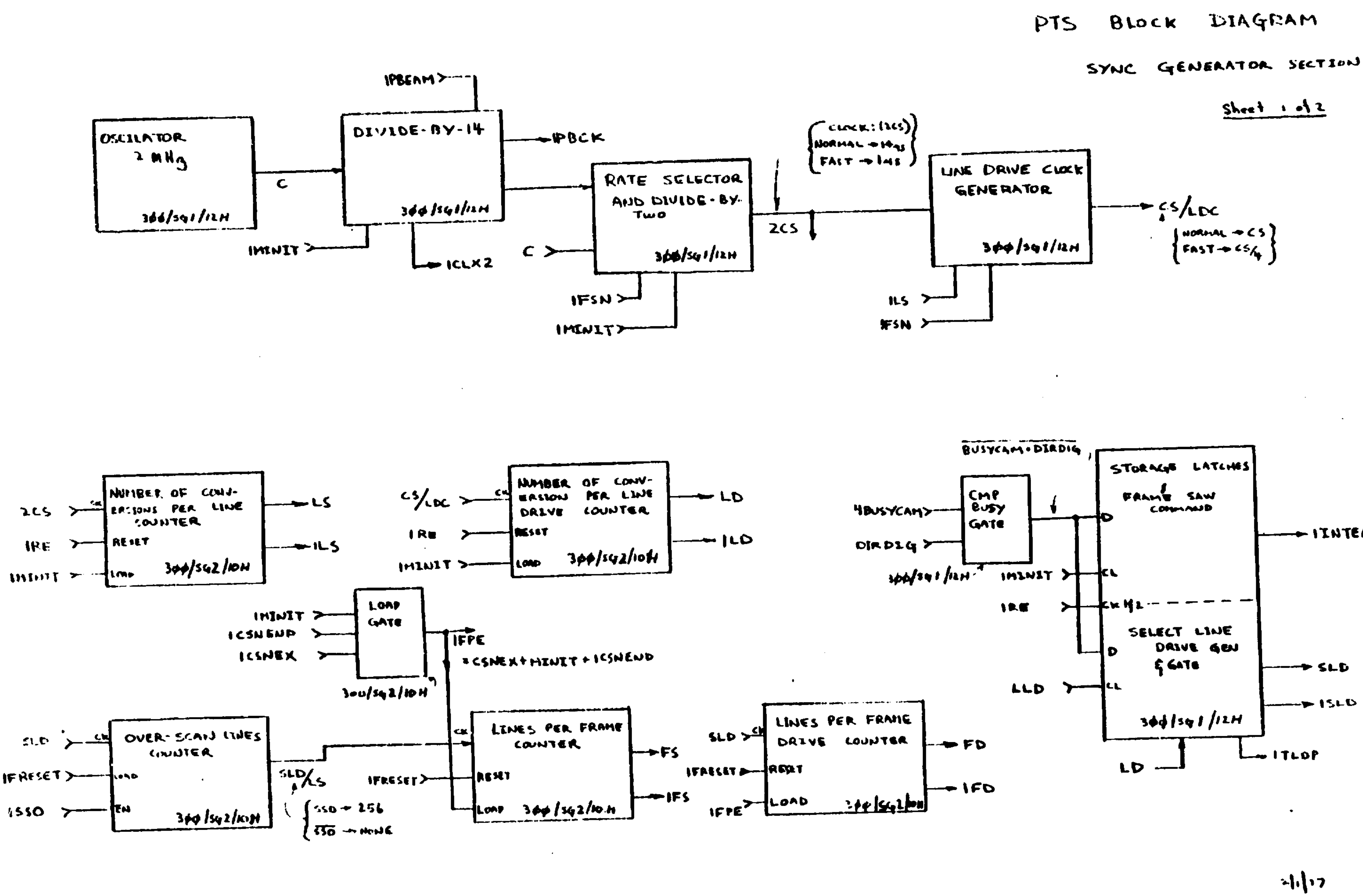
For the "normal" scan rate the pixel period is set at precisely 14 microseconds (for 30 line scans per second). Because it is highly desirable that TV camera raster scans be synchronous with the power line waveform, the first six sets of possible pixel time parameters are as follows.

25 micron Pixel Period (microseconds)	Ideal analog bandwidth kiloHertz	Line scans per second	Frame time (seconds)
7	71.4	60	34
14*	35.7*	30*	68*
21	23.8	20	102
28	17.9	15	137
35	14.3	12	171
42	11.9	10	205

*Selected parameters for the PTS

The time required to complete a TV line scan of 2300 total pixels (2248 real pixels, plus 52 pixels of time for retrace) is 32.2 milliseconds. Since with power line synchronization there will be a new scan started every 33.3 milliseconds, there is 1.1 milliseconds available for power line synchronization and disc overhead of the digitizing system.

The mean power line frequency and phase are obtained by a phase-locked loop circuit. This prevents transient noise and phase jitter of the power line from affecting the camera system operation.



PTS BLOCK DIAGRAM
SYNC GENERATOR SECTION
Sheet 1 of 2
OSCILLATOR 2 MHz
DIVIDE-BY-14
RATE SELECTOR AND DIVIDE-BY-TWO
LINE DRIVE CLOCK GENERATOR
IPBEAM
IPBCK
IMINIT
ICLX2
IFSN
ILS
2CS
CS/LDC
NUMBER OF CONVERSIONS PER LINE COUNTER
NUMBER OF CONVERSION PER LINE DRIVE COUNTER
CMP BUSY GATE
STORAGE LATCHES FRAME SAW COMMAND
SELECT LINE DRIVE GEN & GATE
LOAD GATE
OVER-SCAN LINES COUNTER
LINES PER FRAME COUNTER
LINES PER FRAME DRIVE COUNTER
IINTEG
SLD
ISLD
ITLDP
LD
ILD
LS
IFS
FS
FD
IFD
IFPE
IFRESET
ISSO
ICSNEND
ICSNEX

Figure 71

PTS BLOCK DIAGRAM

SYNC GENERATOR SECTION

Sheet 2 of 2

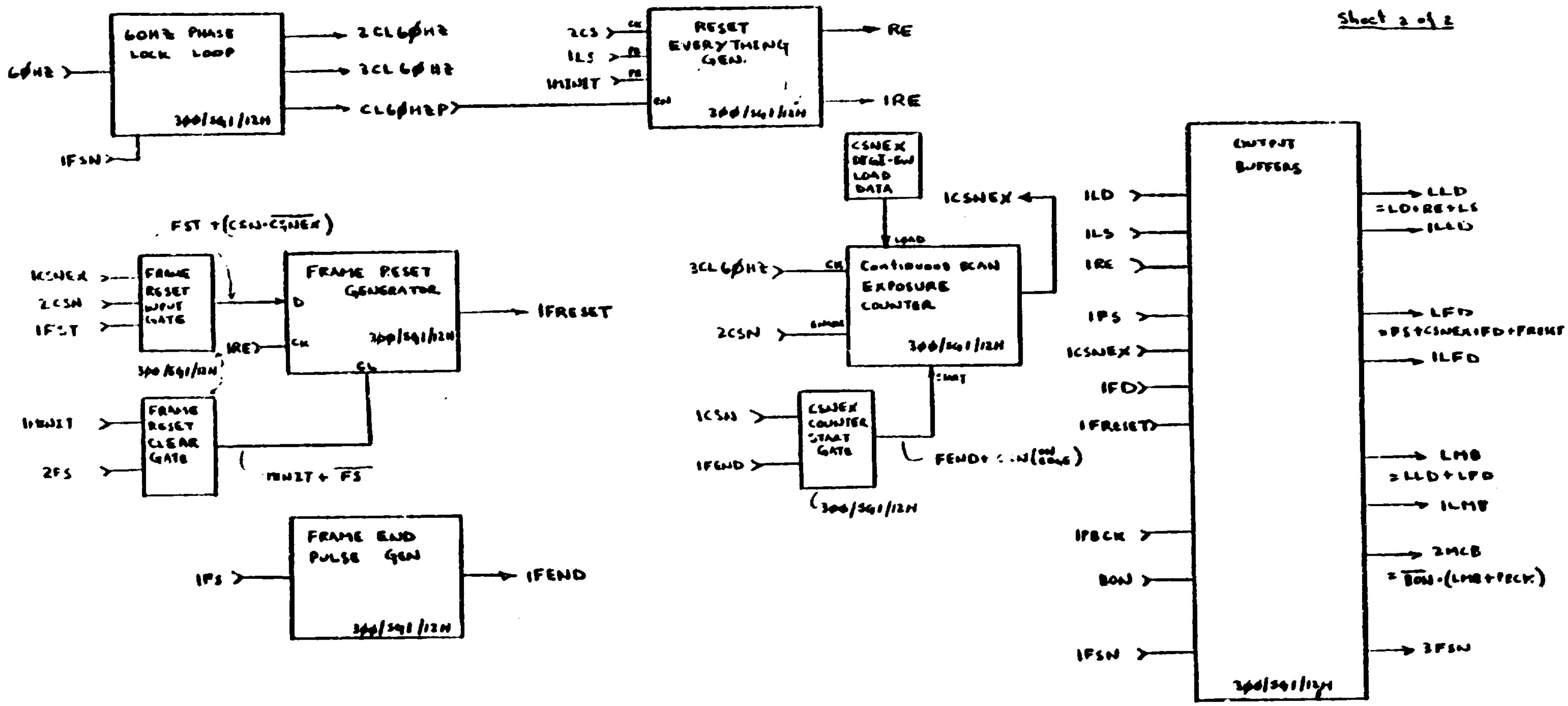


Figure 72

21-1-13

SECTION 71 Pixel[1] Format (line scan direction)

The 70 mm sensor target is 55.6 mm wide. As it is unlikely that the very edges of the active target will ever be as high in quality as the rest of the target, it is desirable to locate the data pixels so that the target edges are not included. However, it is also desirable that the readout electron beam scan the entire target area and a very small additional amount of the target support. This is necessary to avoid uncontrolled charging of surfaces near the useful format, to eliminate beam-pulling and other read beam distortions.

The PTS system provides exactly 2048 quality data pixels, 25.0 microns square, along each raster scan line. 2048 is a particularly appropriate pixel count for data processing purposes. It is also the most data pixels per TV scan line that can be efficiently stored on the system's disc. The 2048 data pixels occupy the center 51.2 of the 55.6 mm target width (2048 x 25μ = 51.20 mm).

The total scan line pixel budget is as follows:

Pixels	mm	Location
12	0.300	On left target support
88	2.200	Left edge of active target area
2048	51.200	Centered, data pixels
88	2.200	Right edge of active target area
12	0.300	On right target support
	56.2 mm	

2248 TOTAL

"52" Equivalent to the time allocated for line deflection retrace.

2300 Pixels per TV scan lines interval.

Note 1: Operational definition of a pixel

A pixel, unless otherwise defined, is the dimensional unit of quantization of the video image. A "data pixel" as used in this report is the image quanta of interest for interpretation of the image sensor performance. Its dimensions are microns^2. The pixel may be sampled one or more times in the digitization process.

SECTION 72 Pixel Format (frame scan direction)

The full active height of the 70 mm SEC target is 50.6 mm in the frame scan (vertical) direction. Using square pixels 25 microns high, a raster of 2048 scan lines covers 51.2 mm. That permits overscanning the target by 0.3 mm (12 pixels) on the top and on the bottom of the target. 2024 lines are on the full active area of the target. Assuming the same 2.2 mm (88 pixel) target edge margins that we have in the line scan direction, 1848 quality data pixels are available in the frame scan direction covering 46.2 mm of the target height.

The time equivalent of 20 lines is allocated for frame scan retrace giving a total of 2068 scan line intervals in a complete frame.

During the target PREPARE cycle it is necessary to overscan the target to insure that the entire target active area is stabilized to the gun cathode potential. (The 0.3 mm target overscan built into the readout raster structure is too small to be relied upon for all scanning modes.) Because changes in the raster pitch (scan lines/mm) can lead to beat patterns between the overscan and normal scan raster, the PTS system achieves frame overscans without changing the raster pitch. This is accomplished in the vertical direction by adding 256 scan lines to the overscan raster (12.5% total overscan) with a vertical centering shift to provide equal overscan top and bottom. Horizintal overscan is achieved by a simple gain charge in the deflection circuit. The frame period for overscan rasters is then somewhat longer than the standard but this is of no practical concern, particularly since it is expected that the overscan frames in a future PREPARE cycle will all be fast scan frames.

Figure 73 details both the vertical and horizontal formal with respect to the target frame.

70 MM SEC IMAGE FORMAT

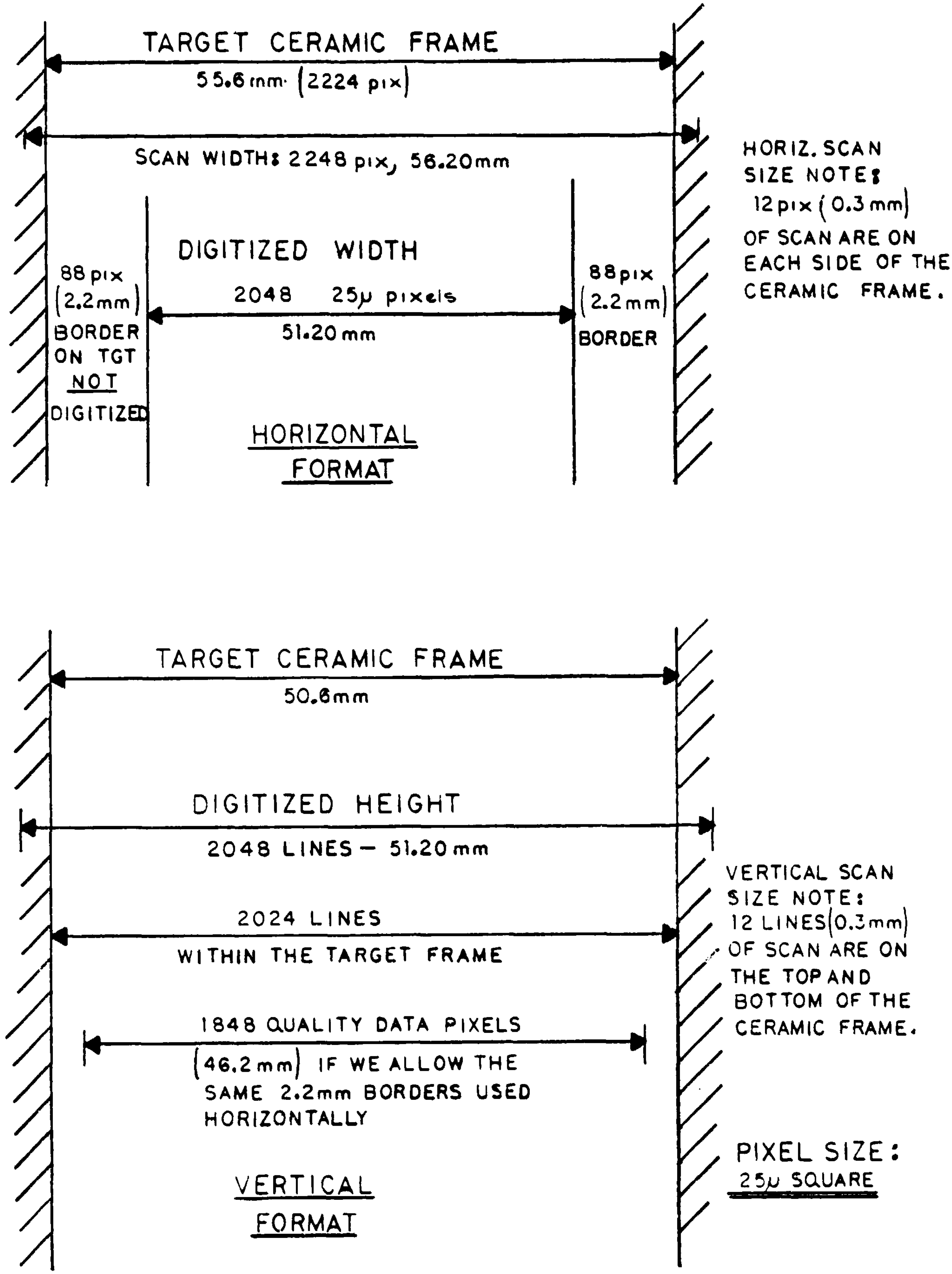


Figure 73

SECTION 73 TV Line Selection

The line select circuit, Figure 74, functions only in the analog mode of operation (Readout of continuous Scan mode). Line select allows the operator to select one of the following three modes:

1. Full (every TV line triggers the oscilloscope).
2. Multi (every N^{th} TV line triggers the oscilloscope).
3. One (the oscilloscope is only triggered on the N^{th} line of the full frame).

The video signal is in each case shown on the TV monitor. For Modes 2 and 3 the selected line or lines are intensified on the monitor.

PTS BLOCK DIAGRAM

TV LINE SELECTOR

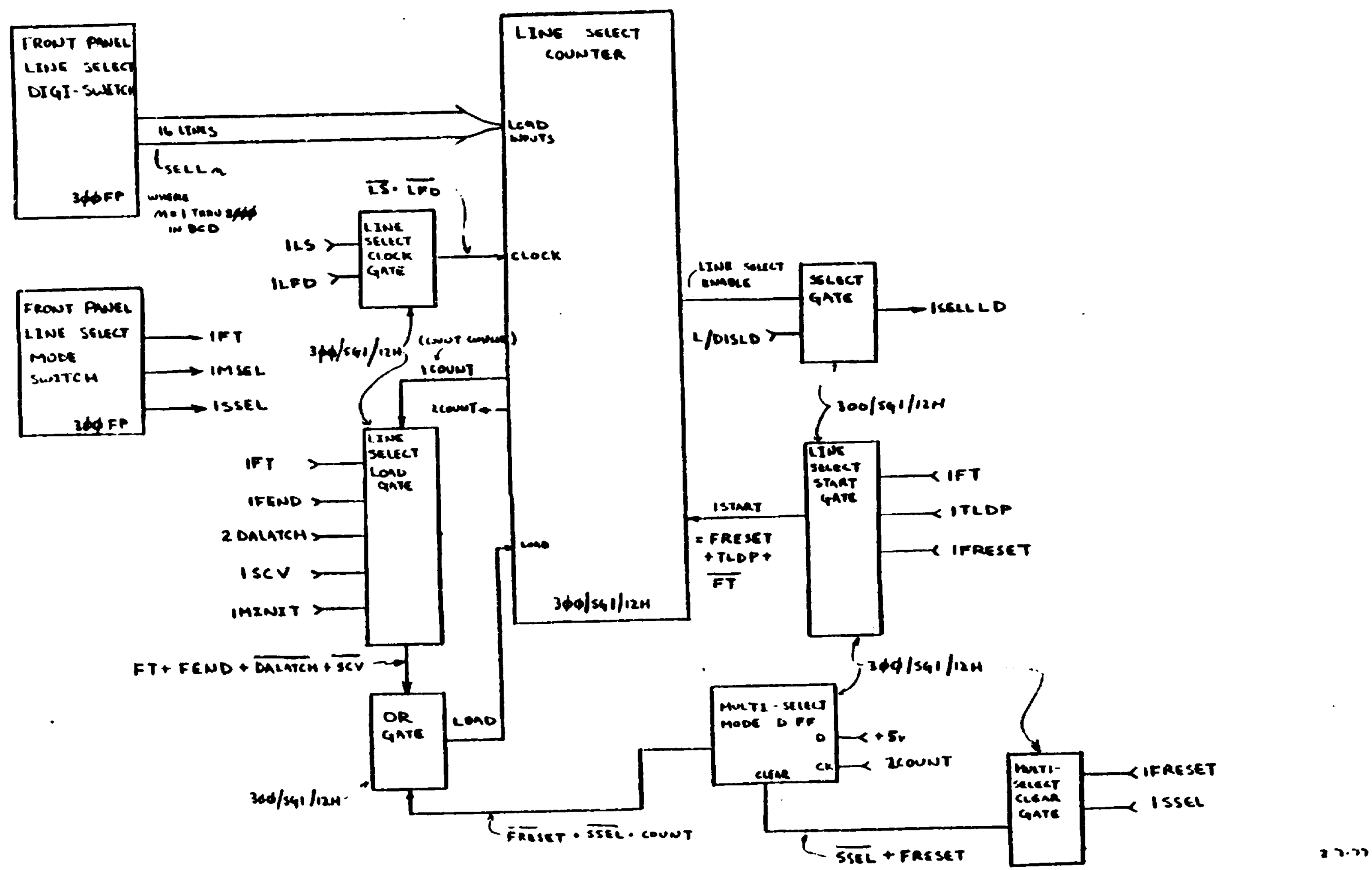


Figure 74

SECTION 80 Computer Camera Control Interface

The computer control of the camera is done via the Datamedia CRT terminal. Commands from this terminal are processed by the Universal Logic Interface (ULI) circuits located in the computer rack and by the Sequence Command (SQ) circuits located in the camera electronics rack. Both the ULI and the SQ circuits serve to transfer the command signals from the computer to the television camera. This dual task is handled by translating the computer's digital information into pulse commands that control the television camera's control sequence and SEC tube parameters.

Camera Control sequences and parameter status for the Prepare, Readout, Expose, and continuous scan modes of operation are detailed in Tables 81 and 82. Tables 83 and 84 define and enumerate the command subdivision. The camera electronics recognizes the control parameters which are the column heading of Tables 81 and 82 as either Action Commands or Function Commands.

The classification of commands as either Action or Function is rather arbitrary, and is primarily a detail of how the commands are encoded for transfer from the computer to the camera. This is necessary because a single command channel cannot accommodate all the required commands. Referring to Figure 81, changes in camera parameters can be achieved by computer commands or manually by means of the Manual Load pushbutton and the Address and Value leverwheel digit switches located on the Control Panel of the camera electronics rack. If the operator desires to override a computer selected parameter, he manually switches the operation of the camera from computer to manual then enters the new parameter via the leverwheel switches on the control panel. When information is transmitted by the computer to the camera electronics, (referring to Figure 81 and Table 84) address information is decoded by the Action or the Function address decoders. Value data is decoded and sent to either the Action or the Function storage latches. The state of these storage latches determines the camera parameter status.

The sixteen bits of data information from the computer are divided into address and value bits. The first twelve bits were allotted for value bits to be used in future systems where the mesh, wall, and beam current type parameters have their absolute values under total computer control. For the PTS system only 3 bits are presently used for level selection.* The four remaining bits are used for addressing information. As 17 addresses are required, the computer's command lines are used to route the four address bits to either action or function latches.

Figure 81 shows the Block Diagram of the Computer Control Interface. The address and value data are received from the computer by digital line receivers. The address and value multiplexer are used to select either the computer data or the information present in the manual mode's address and value digiswitches. The output of the value multiplexer is presented to the inputs of the storage latches.

The computer's command lines, which are used in the action or function selection, are received by line receivers and decoded. In auto mode, the decoded command information is gated with the computer's data valid pulse to enable either the action or function 4 to 16 line decoders. Both 4 to 16 decoders share identical address data on their inputs. The decoder's pulsed output is used to strobe the value information into the addressed latch.

During the manual mode of operation, the manual action/function decoder and address levelwheel replaces the computer command lines to select action or function operation. Also in manual operation, the load pushbutton replaces the computer valid pulse.

---

* Absolute values set manually by adjustable potentiometer.

TABLE 81

PARAMETER STATUS FOR PREPARE CYCLES [2,3]

SEQUENCE	BEAM	HEATER	PHOTO-CATHODE	SCAN SIZE	SCAN RATE	TARGET	MESH	ERASE LIGHTS	LIGHT SOURCE	DIGITIZE	PREAMP TYPE	VIDEO B/W	VIDEO GAIN
PREPARE 1													
Frame: 1-5	High	On	On	Over	Fast	Prepare	Low	On	Off	No	Wide	Wide	2 mv/pa
6	High	On	Off	Over	Fast	Prepare	Low	Off	Off	No	Wide	Wide	2 mv/pa
7	High	On	Off	Normal	Fast	Prepare	Low	Off	Off	No	Wide	Wide	2 mv/pa
8	Off	On	Off	Normal	Fast	Normal	High	Off	Off	No	Wide	Wide	2 mv/pa
9-12	High	On	Off	Normal	Fast	Normal	High	Off	Off	No	Wide	Wide	2 mv/pa
13-14	On	On	Off	Normal	Normal	Normal	High	Off	Off	No	Narrow	40 KHz	2 mv/pa
Default Status[1]	Off	On	Off	Zero	Normal	Normal	Zero	Off	Off	No	Narrow	40 KHz	2 mv/pa
PREPARE 2													
Frame: 1-5	High	On	On	Over	Fast	Prepare	Low	On	Off	No	Wide	Wide	2 mv/pa
6	High	On	Off	Over	Fast	Prepare	Low	Off	Off	No	Wide	Wide	2 mv/pa
7	High	On	Off	Normal	Fast	Prepare	Low	Off	Off	No	Wide	Wide	2 mv/pa
8	Off	On	Off	Normal	Fast	Normal	High	Off	Off	No	Wide	Wide	2 mv/pa
9-12	High	On	Off	Normal	Fast	Normal	High	Off	Off	No	Wide	Wide	2 mv/pa
13-15	On	On	Off	Normal	Normal	Normal	High	Off	Off	No	Narrow	Narrow	2 mv/pa
Default Status[1]	Off	On	Off	Zero	Normal	Normal	Zero	Off	Off	No	Narrow	Narrow	2 mv/pa

(Table continued)

TABLE 81 (continued)

PARAMETER STATUS FOR PREPARE CYCLES [2,3]

SEQUENCE	BEAM	HEATER	PHOTO-CATHODE	SCAN SIZE	SCAN RATE	TARGET	MESH	ERASE LIGHTS	LIGHT SOURCE	DIGITIZE	PREAMP TYPE	VIDEO B/W	VIDEO GAIN
PREPARE 3[4]													
Frame: 1-4	High	On	On	Over	Fast	Prepare	High	On	On	No	Wide	Wide	2 mv/pa
5-6	High	On	Off	Over	Fast	Prepare	High	Off	Off	No	Wide	Wide	2 mv/pa
7	High	On	Off	Normal	Fast	Prepare	High	Off	Off	No	Wide	Wide	2 mv/pa
8-12	High	On	Off	Normal	Fast	Normal	High	Off	Off	No	Wide	Wide	2 mv/pa
Default Status[1]	Off	On	Off	Zero	Normal	Normal	Zero	Off	Off	No	Narrow	40 KHz	2 mv/pa

Notes:

1) Default status is the set of parameter values to which the tv camera is set upon completion of a prepare sequence and at any other time it is desirable to have the camera in a wait state.
2) See Table 83 for nomenclature explanation.
3) See Section 101 for definition of Prepare Cycles.
4) Prepare 3 is currently being used during sensor testing.

TABLE 82

PARAMETER STATUS FOR VARIOUS CAMERA CONTROL SEQUENCES[2,6]

SEQUENCE[1]	BEAM	HEATER	PHOTO-CATHODE	SCAN SIZE	SCAN RATE	TARGET	MESH	ERASE LIGHTS	LIGHT SOURCE	DIGITIZE	PREAMP TYPE	VIDEO B/W	VIDEO GAIN
Analog Readout (Not digitized)	On	On	Off	Normal	Normal	Read	High	Off	Off	No	Narrow	Note 3	Note 3
Readout (Digitize)	On	On	Off	Normal	Normal	Read	High	Off	Off	Yes	Narrow	Note 3	Note 3
Expose	Off	Note 7	On	Zero	Normal	Normal	Zero	Off	On	No	Narrow		
CSNLO[4]	On	On	On	Normal	Normal	Normal	Low	Off	Note 5	No	Narrow	40KHz	2.0 mv/pa
CSNHI[4]	On	On	On	Normal	Normal	Normal	High	Off	Note 5	No	Narrow	40KHz	2.0 mv/pa
FCSNLO[4]	High	On	On	Normal	Fast	Normal	Low	Off	Note 5	No	Wide	Wide	2.0 mv/pa
FCSNHI[4]	High	On	On	Normal	Fast	Normal	High	Off	Note 5	No	Wide	Wide	2.0 mv/pa

Notes:

1) The camera control sequences listed are all VIDEO CSS Procedures, see Section 102.
2) See Table 83 for nomenclature explanation.
3) Video Bandwidth and Video Gain are selected by operator via Computer.
4) Continuous scan with mesh voltage low (CSNLO), Continuous scan with mesh voltage high (CSNHI), Fast Continuous scan with mesh voltage low (FCSNLO), and Fast Continuous scan with mesh voltage high (FCSNHI) are test mode sequences used during initial sensor setup.
5) Light Source is normal on, but maybe programmed off (See Section 102).
6) See Section 101 for definition of READOUT & EXPOSE.
7) Heater voltage status is optional.

TABLE 83

NOMENCLATURE DEFINITION FOR TABLES 81 and 82

BEAM		
	OFF	Electron gun cathode biased off, no beam current present.
	ON	Beam current during active scan time.
	HIGH	Higher beam current used during fast scan modes (depends on each tube).
HEATER		
	OFF	SEC readout electron gun cathode heater state.
	ON	
	OPTIONAL	Sequence will operate in either state. Operator's choice.
PHOTOCATHODE		
	OFF	Photocathode supply switched off.
	ON	Photocathode supply switched on.
SCAN SIZE		
	OVER	Deflection increased by 12.5% of standard format.
	NORMAL	Deflection required for standard format.
	ZERO	No deflection.
SCAN RATE		
	FAST	Vertical Scan of 4.76 sec/frame.
	NORMAL	Vertical Scan of 68.9 sec/frame.
TARGET		
	NORMAL	Target bias used during exposure.
	READ	Normal bias plus 200 mV.
	PREPARE	Normal bias minus one volt.
MESH		
	ZERO	Electrode biased off.
	LOW	Electrode bias of $\approx$ 100 volts.
	HIGH	Electrode bias of $\approx$ 900 volts.

ERASE LIGHTS

OFF	LED'S biased off.
ON	LED'S biased on.

LIGHT SOURCE

OFF	Light source and image projection LED'S biased off.
ON	Light source and image projection LED'S bias on

PREAMPLIFIER TYPE

WIDE	1 mHz bandwidth preamplifier.
NARROW	300 kHz bandwidth preamplifier

VIDEO BANDWIDTH

20 kHz	3db Video Bandwidth	=	24 kHz
40 kHz	"	=	48 kHz
80 kHz	"	=	96 kHz
wide	'	=	880 kHz

VIDEO GAIN

0.5 mv/pa	0.5 mv video output signal for 1 pa tube signal
1 mv/pa	1 mv video output signal for 1 pa tube signal
2 mv/pa	2 mv video output signal for 1 pa tube signal
5 mv/pa	5 mv video output signal for 1 pa tube signal

TABLE 84

CAMERA CONTROL COMMANDS

Action Commands	Address[3]	VALUE[3] 0	1	2
Heater (SEC tube gun)	0	Off	On	
Scan Rate	1	<u>Normal</u>	Fast	
Scan Size	2	<u>Zero</u>	Normal	Over
Target Voltage	3	Prepare	<u>Normal</u>	Read
Mesh Voltage	4	<u>Zero</u>	Low	High
Photocathode voltage	5	<u>Off</u>	On	
Beam current	6	<u>Off</u>	On	High
Erase Lamps	7	<u>Off</u>	On	
Light Box[5]	8	<u>Off</u>	On	
Shutter[2]	9	<u>Closed</u>	Open	
Start Frame	10	Start		
Continuous Scan	11	<u>Off</u>	On	
Digitizing	12	<u>Off</u>	On	

Function Commands		VALUE 0	1	2	3
Pre-Amp Selection	20	<u>Narrow</u>	Wide		
Video Bandwidth	21	20 kHz	<u>40 kHz</u>	80 kHz	Wide
Video Gain (mV/PA)	22	.5	1.0	2	5
Beam Select:Normal,Pulsed[4]	23	<u>Normal</u>	Pulsed		

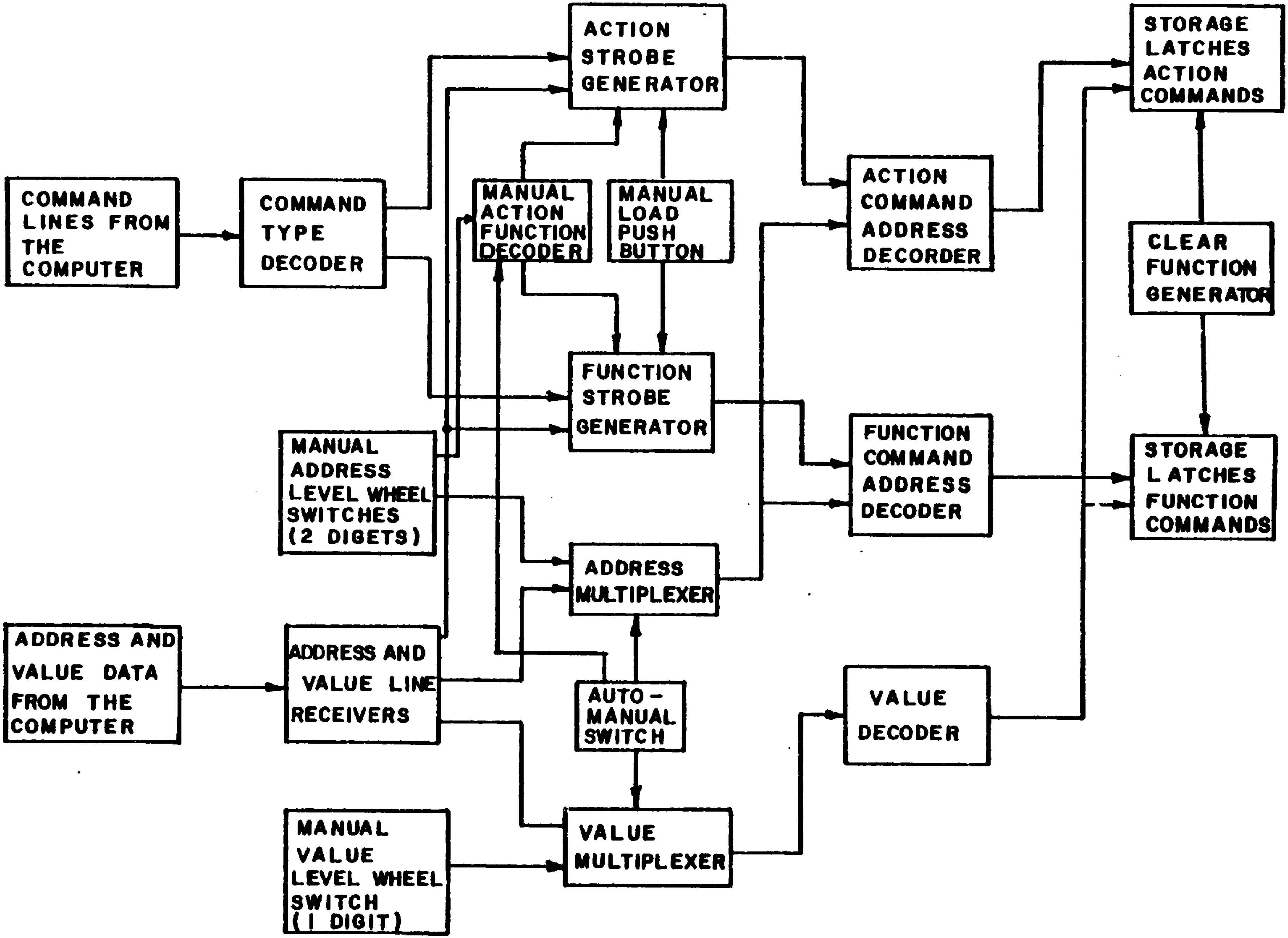
Note:1) Underlined condition indicates the default values which are automatically selected whenever 1) the camera is turned ON, 2) the computer initialized, 3) a Reset command is executed by the software, or 4) the Control Panel reset button is pushed.

2) The Shutter command is not used by the PTS hardware since the light box itself is electronically shutterable.

3) Leverwheel switch selection.

4) Used for spectrally separating video image data from microphonics.Refer to Sect. 60.

5) The choice of LED color or incandescent light is a manual selection.



BLOCK DIAGRAM COMPUTER CAMERA CONTROL INTERFACE

Figure 81

SECTION 90 Digital Data Processing Equipment

The digital data processing equipment consists of an Interdata Model 7/32 Processor (a 32-bit computer), a Pertec Model D3442 magnetic disc system, and a Pertec Model T9640-9 magnetic tape transport and tape formatter. The operator interface to the system is a Datamedia Elite 1520 CRT terminal.

When integrated with the computer ULI cards and the A/D conversion network, the data processing equipment provides for transfer of data directly to magnetic disc for storage on the magnetic tape. As video data transfer from the television camera to the disc is accomplished in real time, while data transfer to magnetic tape takes 2½ times longer, maximum utilization of the test set is accomplished by first transferring and storing data on the disc system. After this has been done, the multitasking feature of the software system allows for automatic preparing of the SEC tube for the next exposure, while at the same time transferring the stored video data from the disc to magnetic tape.

The ability to store data on the magnetic tape allows for the transferring of data for analysis to other computer facilities, such as the Princeton IBM 360-91.

Tables 91 through 95 detail the specifications of the subsystems of the PTS computer.

SPECIFICATIONS

Technology

Processor – T^2L – MSI and LSI

ROM – BiPolar LSI (60 ns Access Time)

Processor

Instruction Word Length – 16, 32, 48 Bits

Data Word Length – 8, 16, 32 bits

General Registers – 32 BiPolar hardware registers (32 bits each) separated into two stacks of 16; 30 usable as INDEX registers

Floating Point Registers – 8 registers (32 bits each-in main memory)

Direct Addressing – up to 16, 777,216 bytes

Arithmetic – two's complement (Fixed Point) – Sign/magnitude (floating point)

Instruction Repertoire – 175 instructions including multiply/divide, and list processing. Floating point instruction set is optional. (17 additional)

Processor
Input/Output Modes – Programmed transfers, 26 – 150K
8 or 16 bit transfers
– Block transfer up to 360K bytes/sec.
– Auto driver channel, 70K bytes or halfwords/sec.
– 7 DMA ports available
– DMA Transfer – 2.0M bytes/sec.

Priority Interrupts – Identification of up to 1024 hardware levels with automatic device identification and vectoring.

**Interrupt Overhead Time* – 6.5 μs

Normal Interrupt Latency Time – 4.0 μs

Hardware I/O Timeout – 14 μs timeout on all micro processor operations to the I/O system, thereby ensuring that the processor will not lock-up should a module stall or otherwise fail to respont.

**Overhead time to allow servicing interrupts, including device identification, status recognition, and PSW swapping.*

MAIN MEMORY

Word Length – 16 bits (17 with parity option)

Organization – 8KB, 16KB and two types of 32KB modules available on single 15" plug in boards

Cycle Time – 8KB – 1000 nanoseconds
16KB – 1000 nanoseconds
32KB – 750 and 1000 nanoseconds

Maximum Memory Size – 1,048,576 Bytes

ENVIRONMENTAL

Temperature – 0-50°C

Humidity – 0-90% (non condensing)

Vibration – 0-55 CPS at 1.25 G's

Storage Temperature – –55°C to +85°C

PACKAGING

19" RETMA chassis, 14" high, 28" deep
15" x 15" printed circuit boards with ¼" aluminum stiffeners arranged horizontally
printed circuit backpanel
Pin to dual contact receptacle connections with locating pins
dual chassis with 16-15" board slots
processor occupies 3 boards, memory modules, 1 board

Power 115 or 230 VAC ± 10%, 50 or 60 Hertz, 16 amps max. (at 115 volts)

OPTIONAL DISPLAY CONSOLE

36 Binary Indicating LED's
9 Hexadecimal Display Matrices
16 Hexadecimal Character Keys
10 Function Select Keys
5 Function Indicating LED's
1-3 Position Keylock Switch

INTERDATA PRODUCT NUMBER: M73-023

Table 91

INTERDATA 7/32 PROCESSOR SPECIFICATIONS

Series Magnetic Tape Transports Specifications

Reel Size	10½ inch
Number of Tracks	9-track IBM compatible
Recording Mode	Phase-Encoded (PE) units IBM and ANSI compatible
Data Density	9-track Phase Encoded—1600 CPI
Tape Velocity	
Instantaneous Speed Variation	±3% max.
Long-Term Speed Variation	±1% Forward, ±3% Reverse
Start/Stop Time	5.0 ms ±0.35
Start/Stop Displacement	0.19 inch ±0.02 (4.83 mm ±0.51)
Rewind Time	115 seconds — full reel
Tape Handling	
Width	0.5 inch (12.7 mm)
Thickness	1.5 mil (38.1 microns)
Tension	8 ounces (226.7 grams)
Type	Computer grade. ANSI Spec. #X3.40-1973
Environment	
Operating Temperature	40° to 110°F (5° to 40°C)
Relative Humidity	30 to 80% non-condensing
Altitude	0 to 4,000 feet (1218 meter) standard 4,000 to 7,000 feet (1218 to 2132 meter) with kit
Mechanical Description	
Mounting	Standard EIA rack mount
Weight	155 lbs. (70.3 Kg)
Height	24 inches (61 cm) supplied with ½ inch filler panel
Width	19 inches max. (48.3 cm)
Depth (behind panel)	18 inches (40.6 cm)
Electrical Requirements	
Electronics	Silicon solid state and 930 series DTL logic
Interface	DTL, TTL-compatible logic (low true)
Power	95/250 Vac, 47 to 62 Hz, 450 watts nominal

Table 92

PERTEC TAPE TRANSPORT SPECIFICATIONS

SPECIFICATIONS

Data Density	9-Track 1600 cpi phase-encoded
Tape Velocity	75,
Recording Mode	Phase-encoded compatible with IBM and ANSI standards
Compatible Tape Transports	Any Pertec 5000-, 6000-, or 7000-Series Transports
Electronics	7400-Series, TTL Logic with DTL interface
Power	117/230 Vac. 48 to 400 Hz, 100 Watts maximum
Environment (operating)	
Temperature	35°F to 122°F (2°C to 50°C)
Altitude	Sea Level to 20,000 feet
Humidity	10% to 95% non-condensing
Mounting	Standard EIA Rack Mount (slides provided)
Weight	25 lbs maximum
Dimensions	
Height	3.5 inches
Width	19.0 inches
Depth	20.0 inches

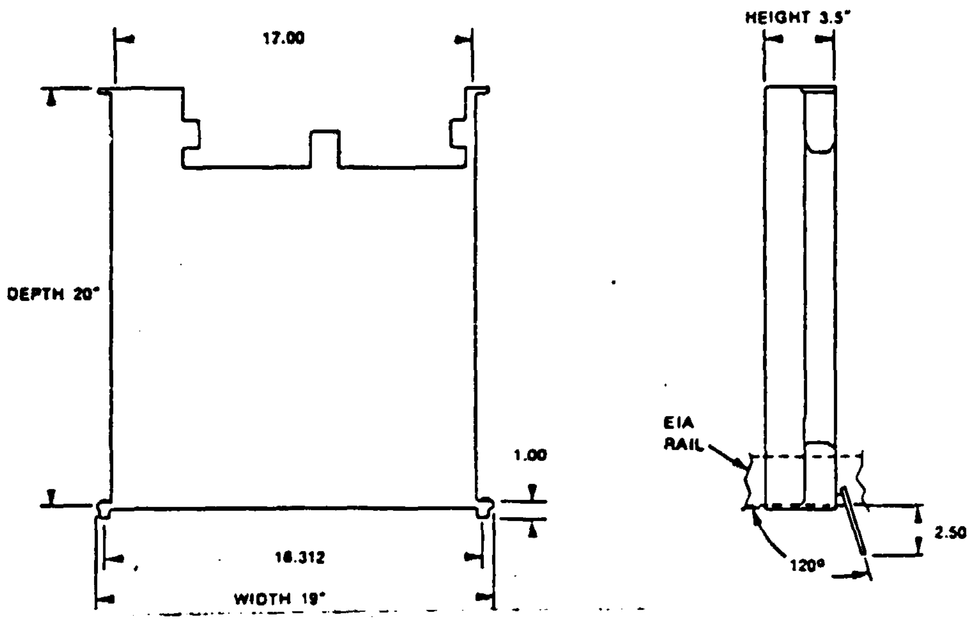


Table 93

PERTEC TAPE FORMATTER SPECIFICATIONS

Pertec D3000 Disk Drive Specifications

Recording Technique	Double Frequency	
Data Rate	1.562 MHz' at 1500 rpm - 2.5 MHz at 2400 rpm	
Recording Medium	2315 cartridge or 5440 cartridge available	
Speed		
Rotation (rpm)	1500 ± 1% or 2400 ± 1%	
Latency Average	20 ms at 1500 rpm	12.5 ms at 2400 rpm
Positioning (Incl. settle)	100 tpi	200 tpi
Track-to-Track	9 ms	10 ms
Average	35 ms	40 ms
Maximum	60 ms	65 ms
Physical		
Width	Standard 19-inch panel width (48.3 cm)	
Depth	26-inch rack depth (66 cm); 3¼-inch front overhang (8.3 cm)	
Height	8¾-inches (22.2 cm)	
Weight	130 pounds (incl. slides) (59 kg)	
Power Required		
AC Power	95-250V By Transformer Tap Changes 48-52 Hz or 58-62 Hz	
Allowable Voltage Variation	± 10% of Nominal	
Environment		
Temperature—100 tpi		
Operating	+ 50°F to + 104°F (10°C to 40°C)	
Non-operating	+ 14°F to + 149°F (−10°C to 65°C)	
Temperature—200 tpi		
Operating	+ 60°F to + 100°F (15°C to 38°C)	
Non-operating	+ 14°F to + 149°F (−10°C to 65°C)	
Relative Humidity	5% to 85% (without condensation)	
Altitude	Sea level to 7500 ft. (2286 meters)	
Capacity		D3442
Bit Density		2200 bpi
Track Spacing		0.005 in./200 tpi
Bits per Platter		
Fixed		50,000,000
Removable		50,000,000
Bits per Drive		100,000,000
Sectors per Track		N
Tracks per Unit		1624
Cylinders per Unit		406

Table 94

PERTEC MAGNETIC DISC SPECIFICATIONS

ELITE 1520A APL/ASCII SPECIFICATIONS

SCREEN CAPACITY	1920 characters
SCREEN TYPE/SIZE	P4 white, 12 inch
SCREEN FILTER	Gray
CHARACTERS PER LINE	80
LINES OF DISPLAY	24
CHARACTER GENERATION	5 x 7 dot matrix within a 5 x 9 dot field to provide true lower case descenders
CHARACTER SIZE	0.18"H x 0.09"W
CHARACTER SET	Full ASCII - upper/lower case 128 codes stored
REFRESH RATES	60 Hz
DATA RATES	50 to 9600bps, asynchronous
MEMORY TYPE	MOS
KEYBOARD	Electronic, typewriter layout with numeric cluster and cursor controls
CURSOR	Addressable X-Y coordinates; non-destructive, blinking cursor up, down, right, left, home and fixed tab
KEY CONTROLS	Erase screen, erase to end of page
OPERATING MODES	Full or Half Duplex, Roll or Tape Mode
ALARM	Audible on alarm code or eight characters from end of line
INTERFACE-LINE	RS232C; lamp indicators for carrier detect, and clear to send
INTERFACE-PRINTER	Printer output computer or keyboard-controlled
VIDEO OUTPUT	Provision to drive up to 16 external monitors

DIMENSIONS	Display/Controller	Keyboard
Depth	35.24cm (13.875 in.)	21.21cm (8.35 in.)
Height	37.78cm (14.875 in.)	8.38cm (3.30 in.)
Width	35.56cm (14.00 in.)	45.72cm (18.00in.)
Weight	14.06kg (31 lbs.)	3.25kg (7.16 lbs)

OPERATING ENVIRONMENT	$+10^{\circ}C$ to $+40^{\circ}C$ ($+50^{\circ}F$ to $+100^{\circ}F$) Humidity +10% to +80% (non-Condensing)
POWER	100/125V 50/60Hz 75 Watts

Table 95

ELITE 1520 CRT TERMINAL SPECIFICATIONS

SECTION 100 PTS Operation

In this section the PTS operation is discussed in the context of its primary function, the testing of SEC television camera tubes. The control of the system by mini-computer is explained including a listing of the software command and a computer listing of a typical operating session.

SECTION 101 SEC Testing with the PTS

The quantitative testing of SEC sensors involves three basic operating sequences. They are called PREPARE, EXPOSE and READOUT.

In a PREPARE Sequence the SEC Sensor operating conditions are cycled through a sequence designed to remove residual images and other effects of the previous exposure from the storage target of the SEC sensor. The SEC sensor's photocathode is flooded with light at the beginning of a PREPARE cycle in order to remove buried charge patterns from the previous exposure to the SEC storage target.

The optimum PREPARE cycle for SEC sensors is still undergoing development, and as it is a function of the detailed SEC target characteristics it can be expected to continue to evolve during the SEC sensor development. One of the major advantages of the computer controlled parametric test set is that the details of the PREPARE cycle can be easily modified by software. The current PREPARE cycle recipe is stored in the computer in the form of a list of camera commands that can be revised from time to time by the test set operator. In fact, there is usually more than one PREPARE cycle residing in the computer at any time, so a different PREPARE cycle can be tried without revising the others. They are called by name from the console, e.g., PREP 3, PREP TEST, etc.

The stored PREPARE cycles are executed by computer program known as the Camera Control Task (see, for two examples, the Parameter Status, Table 81,

for PREP 1 and 2 given in Section 80). As explained in Sections 102 and 103 which follow, the Camera Control Task is initiated when the operator enters via the system keyboard the name of the Camera Control Task he wishes executed. In the case of a PREPARE cycle he would type PREP, space, and a number or label which identifies which PREPARE cycle he wants executed.

To EXPOSE the sensor via the computer, the operator types EX (or EXpose[1]) and enters the desired exposure time in seconds. After this has been entered, the photocathode voltage is turned ON. A 15 second time delay allows the photocathode voltage to stabilize before the light source is turned ON. At the end of the exposure, the light source is turned OFF.

Before you can digitize the READOUT of the video signal, the operator must type DIGitize and then answer the system questions. See Section 103 and keyed notes. The digitized data is first recorded on disc, then transferred to tape. In the manual mode, the PREPARE, EXPOSE, and READOUT sequences are commanded from the console of the Electronics Rack. See Tables 81 and 82 for parameter status and Table 84 for the correct Address and Value code.

The Test Plans for the various parametric tests required on the SEC sensor are listed in Section 110.

All three sequences are required to execute a representative test plan. For illustration consider the recording of photometric exposures. The photometric test requires a series of exposures of a special test chart at different light levels as shown in the photometric test plan (see Section 110). To make any one of these exposures the operator proceeds as follows:

1. Prepares the SEC sensor by executing the appropriate PREPARE cycle.
2. Executes an EXpose command of the proper time duration for the exposure level required for this frame.

---

[1] As per the usual convention, the allowable abbreviation of a command is that portion printed in upper case letters.

3. Digitizes the video signal produced by the READOUT of the photometric frame and stores the result on the disc by means of the data task command DIGitize as shown in Sections 102 and 103.

After the readout of the target is completed, the operator can issue a PREP cycle command. While the PTS is preparing the sensor for the next photometric exposure, the data task command (DA) can be used to transfer the frame just digitized from the system disc to the magnetic tape unit. At about the same time the transfer of the previous photometric frame to magnetic tape is completed the preparation of the sensor for the next exposure will also be completed. The operator then makes the next exposure in the sequence of the test plan and continues as above until all the required photometric frames have been exposed, readout, digitized and transferred to magnetic tape. These magnetic tapes are the output of the parametric test set. This raw data is reduced on a general purpose computer to yield the photometric tube performance measurements required.

SECTION 102 PTS Operation via the Computer

In order to PREPARE, EXPOSE, and READOUT the target in a semi-automatic mode, it is necessary for the operator to use both the Camera Control Task (CC) and Data Task (DA). The allowable minimum abbreviation for a command is that part printed in capitals.

102.1 CC tasks:

CAMERA

REset	Resets camera controller to default values[1].
PREPare <#>	Prepare, enter desired recipe in place indicated by < >. See Table 81.
EX <time>	Expose, enter desired time in seconds in place indicated by < >.
ZEX	Zero exposure.
EXOFF <time>	Expose with the sensor heater off (time in seconds).
ZEXOFF	Zero exposure - heater off.
CSNLO <note 3>	Continuous scan with the mesh voltage low.
CSNHI <note 3>	Continuous scan with the mesh volt.
FCSNLO <note 3>	Fast Continuous scan with the mesh voltage low.
FCSNHI <note 3>	Fast Continuous scan with the mesh voltage high.

Notes:

(1) See Table 84.

(2) Each TV data frame occupies a file on the tape.

(3) The light source is normally ON during this task. To enter this task with the light source OFF, the operator must type OFF after typing tne appropriate task command. For example:

CSNLO	Continuous scan with the mesh voltage low and the light source ON.
CSNLO OFF	Continuous scan with the mesh voltage low and the light source OFF.

These continuous scan modes are used during the initial tube setup. Light Source is commanded ON to expcse the SEC Target.

102.2 DA Tasks:

FOrward or FF	Moves tape forward to the end of file[2]. (Refer to note on previous page.)
BAckward or BF	Moves tape backward to the beginning of file.
FIle <number>	Moves tape to designated file.
REwind or RW	Rewinds tape to File 1.
SKip	Moves tape forward to the end of data[1].
Header	Prints particular header of called device, Tape or Disc. For example: D H displays disc header information; D T displays tape header information of positioned file.
Disc	Identifies device called when using Header command.
Tape	Identifies device called when using Header command.
BUrst	Provides 7 example-pixel testing.
STatus	Displays all error bits in active header.
TD	Moves data from Tape to Disc.
DT	Moves data from Disc to Tape
DIGitize	Begins digitizing process.
MONitor	Displays data on slow scan monitor.
PAuse	Ends task
SL	Standard Label - Skips 1st file which is standard label.
NL	No Label - Does not skip the 1st file.
ENd	Ends CC or DA Task.

Note: Capital letters indicate minimum entry word.

102.3 Operator Aids:

1. Terminal prompts

DA> Data task - waiting for your response.

* Operating system - You may enter a CC task command, define a task, or continue a task.

1 Beyond the last TV frame recorded on the tape.

2. *DA>? Will list data task commands.

3. *CC? Will list camera control tasks.

4. To change from a DA task to a CC task. Type PA (pause) after the DA> prompt.

5. If you want to be in a DA task. After the * prompt type:

   *T DA

   COntinue

102.4 Computer Turn ON Procedure (loading the program)

Power up the 7/32 processor, tape drive and formatter, disc and terminal.

Disc	-after SAFE light actuates, insert the removable disc. Depress run switch.
Tape Drive	-mount a 1600 BPI, IBM 360-91 comptuer compatible tape. Advance to the BOT and depress ON - LINE
Disc	-when the ready light actuates, you can now load the program by depressing INI on the 7/32 Computer front panel control.

Section 103 Computer Listing of a PTS Operating Session

This section includes a printout which details all the commands and system responses encountered when the computer is used to test cycle a 70-mm SEC sensor. Included is a numbered list of notes keyed to the printout. The basic steps required are:

+ Load the program. (Items 1-4).
+ Identify the hardware. OBSCAM or the PTS system. (Item 7).
+ Answer the standard label question. (Item 8).
+ Pause the DA task in order to prepare the tube. (Item 15).
+ Prepare the tube. Type PREP 1. (Item 17).
+ Expose the tube. Type EX (time). (Item 19).
+ Identify the next task as a DA task. (Items 20 and 21).
+ Type DIG to enter digitizing mode. Operator defines digitizing parameters, enters general header, enters particular header. There are three lines of 64 characters each available for each type of header.
+ Type DT (disc to tape transfer) to enter data transfer mode. Operator decided if all 2048 digitized lines or a selected number are to be transferred to the tape, and operator enters a new tape name if necessary. (Items 29 and 30).
+ Operator can view on the slow scan display, all of the data on the disc by typing MON, or display a selected number of lines. (Items 31 and 32).

To begin another PREPARE, EXPOSE, READOUT cycle the operator must end the DA task and return to the operating system. (Repeat Item 15).

As an aid in following these PREPARE, EXPOSE, and READOUT cycles executed by the computer, the listing has been annotated. To distinguish computer from operator actions, all entries typed in by the operator are underlined in the following listing.

```
OS32MT 1-02  1
*MA RD:,ON   2
RD  :   PTS
*SE TI 3/18/77,14:58:00 3
*VIDEO 4
**
**                VIDEO SYSTEM CSS PROCEDURES  5
**
**GENERAL
**   VIDEO, BYE, BURST, LATCH, INITIAL, ECHO, NOECHO  6
**
**CAMERA CONTROL
**   CAMERA
**   RE
**   PREP <prepare cycle name>

**
**   EX <time>
**   ZEX
**   EXOFF <time>
**   ZEXOFF
**
**   CSNLO (OFF)
**   CSNHI (OFF)
**   FCSNLO (OFF)
**   FCSNHI (OFF)
*$NOCOPY
**LATCH INITIALIZATION STARTING
*$NOC
*14:58:29    .BG:END OF TASK      0
*14:58:39    DA:VIDEO DATA TASK
*14:58:41    DA:VIDEO DATA TASK
*14:58:42    DA:ARE YOU USING OBSERVING CAMERA HARDWARE?
*DA>N  7
*14:58:47    DA:DO YOU WISH TO PRESERVE A STANDARD LABEL?
*DA>N  8
*14:58:51    DA:  9
*14:58:52    DA:DISC FILE: 10
*14:58:53    DA:NONE 11
*14:58:54    DA:  9
*14:58:55    DA:TAPE EDEN 2    FILE  1: 12
*14:58:57    DA:TEST 13
*DA>? 14
*14:59:02    DA:FOrward, FF, Backward, BF, FIle, Rewind, RW, SKip, Header,
*14:59:05    DA:BUrst, Status, TD, DT, DIGitize, Monitor, PAuse, Disc, Tape
*14:59:08    DA:SL, NL, ENd
*DA>PA 15
*14:59:24    DA:TASK PAUSED
*ECHO 16
*PREP 1 17
*14:59:44    CC:CAMERA CONTROL TASK
*14:59:46    CC:DEFAULTS
*14:59:47    CC:QUALIFY
*14:59:48    CC:BANDWIDTH WIDE
*14:59:49    CC:PRE-AMP WIDE
*14:59:50    CC:TARGET PREPARE
*14:59:52    CC:MESH LOW
*14:59:53    CC:RATE FAST
```

1. System response when the operating system program is loaded.
2. Operator marks the removable disc on line.
3. Operator sets time and date.
4. Operator types VIDEO. The computer enters and lists the Command Substitution System (CSS) procedures. Lists the CC tasks and enters the DA tasks.
5. The Command Substitution System (CSS) provides the user with the ability to establish files of commands which can be called from the console or other CSS files and executed in a sequence. In this way complex sequences of commands can be carried out by the operator with only a small number of commands.[1]
6. The general CSS procedures that the VIDEO program provides are:

VIDEO	(See 4).
BYE	Ends CC and DA tasks. Used during system shutdown.
BURST	Provides 7 sample/pixel testing. Useful in resolution measurement. Refer to Section 60.
LATCH	Sets the VIDEO system output relay to the live mode.
INITIAL	Used to initialize tapes not previously used on this computer.
ECHO	Allows for a display of camera control commands during execution of stored sequences. Useful for monitoring a PREPARE cycle.
NOECHO	Ends ECHO display.

7. Yes or No Sets monitor retrace time. Because the same software is used for the 70-mm Observing Camera, it is necessary to identify the system being used.
8. Yes or No (Some Princeton University Computer Center Tapes have a special first file which is a label.)
9. An intentional blank line intended to enhance the legibility of the printouts.
10. Identifies 11 as disc information.
11. First line of particular header. Will be "NONE" when the system is first turned on.
12. Identifies the name of the tape and what file is next.
13. First line of particular header information of tape. Will be blank with a new tape.
14. Operator can enter any DA task command. Entering a "?" will list all the DA commands. Capital letters denote minimum entry word.
15. PA Pauses the DA task.
16. ECHO (See 6)
17. See following page.

Note 1: Refer to Interdata OS/32-MT Program Reference Manual Section 5-25

```
*14:59:54   CC:SIZE OVER
*14:59:55   CC:ERASE-LIGHTS ON
*14:59:57   CC:PHOTOCATHODE ON
*14:59:58   CC:BEAM HIGH
*14:59:59   CC:START
*15:00:00   CC:TIMER 5
*15:00:06   CC:
*15:00:07   CC:START
*15:00:08   CC:TIMER 5
*15:00:14   CC:START
*15:00:15   CC:TIMER 5
*15:00:21   CC:START
*15:00:22   CC:TIMER 5
*15:00:28   CC:START
*15:00:29   CC:TIMER 5
*15:00:35   CC:
*15:00:36   CC:PHOTOCATHODE OFF
*15:00:37   CC:ERASE-LIGHTS OFF
*15:00:39   CC:START
*15:00:40   CC:TIMER 5
*15:00:46   CC:
*15:00:46   CC:SIZE NORMAL
*15:00:48   CC:START
*15:00:49   CC:TIMER 5
*15:00:55   CC:
*15:00:56   CC:TARGET NORMAL
*15:00:57   CC:MESH HIGH
*15:00:58   CC:BEAM OFF
*15:00:59   CC:ST
*15:01:00   CC:TIMER 5
*15:01:06   CC:
*15:01:07   CC:BEAM HIGH
*15:01:08   CC:START
*15:01:09   CC:TIMER 5
*15:01:15   CC:START
*15:01:16   CC:TIMER 5
*15:01:22   CC:START
*15:01:23   CC:TIMER 5
*15:01:29   CC:START
*15:01:30   CC:TIMER 5
*15:01:36   CC:
*15:01:37   CC:RATE NORMAL
*15:01:38   CC:BEAM NORMAL
*15:01:39   CC:BANDWIDTH 40
*15:01:41   CC:PRE-AMP NORMAL
*15:01:42   CC:START
*15:01:43   CC:TIMER 70
*15:02:54   CC:START
*15:02:55   CC:TIMER 70
*15:04:06   CC:DEFAULTS
*15:04:07   CC:END OF CAMERA COMMAND INPUT
*15:04:09   CC:TASK PAUSED
*NOECHO 18
*EX 4 19
*15:04:36   CC:CAMERA CONTROL TASK
*15:04:56   CC:END OF CAMERA COMMAND INPUT
*15:04:58   CC:TASK PAUSED
*T DA 20
*CO   21
*DA>DIG 22
*15:05:17   DA:DIGITIZING PARAMETERS:
*15:05:19   DA:
*15:05:19   DA:BANDWIDTH:              40 KHZ.
*15:05:21   DA:GAIN:                   1 MV./PA.
*15:05:23   DA:PRE-AMP:                NARROW
*15:05:25   DA:BEAM:                   NORMAL
```

17. PREP 1 Begins tube Prepare cycle. When a PREpare command is initiated, the system first goes to the default values listed in Table 84. The computer then changes sensor and system parameters to the called for PREpare recipe values.
START - Camera begins 1 frame of readout.
TIMER 5 - Computer initiates a 5 second time delay for the 4.8 second readout.
After 5 frames of readout, the photocathode and erase-lights are turned off. This is followed by a 1 frame readout. Scan size is set to normal then followed by a 1 frame readout. Target voltage is set to normal, mesh voltage is set high, and the beam is set off then followed by a 1 frame scan. Beam current is set for high then followed by 4 frames of readout. Scan rate is set normal (On), bandwidth set to 40 kHz, pre-amphifier type is set normal (Narrow), then followed by two 70 second time delays which allows for a 68 second readout. After the second 68 second readout, the sensor and system are again set to the default values listed in Table

18. NOECHO Ends ECHO mode.
19. EX (time) Begins an exposure, time in seconds.

20. T DA Identifies the next task as a data task.
21. CO COntinue a task which had been paused.
22. DIG Command to enter digitizing mode.

```
*15:05:27   DA:
*15:05:28   DA:OK?
*DA>N (23)
*15:05:32   DA:
*15:05:33   DA:BANDWIDTH:
*15:05:34   DA:  0:  20 KHZ.
*15:05:36   DA:  1:  40 KHZ.
*15:05:37   DA:  2:  80 KHZ.
*15:05:38   DA:  3:  WIDE
*15:05:40   DA:
*15:05:40   DA:YOUR CHOICE:  *DA>0
*15:05:46   DA:
*15:05:47   DA:GAIN:
*15:05:48   DA:  0:  .5 MV./PA.
*15:05:49   DA:  1:  1 MV./PA.
*15:05:51   DA:  2:  2 MV./PA.
*15:05:52   DA:  3:  5 MV./PA.
*15:05:54   DA:
*15:05:54   DA:YOUR CHOICE:  *DA>2
*15:05:58   DA:
*15:05:59   DA:PRE-AMP:
*15:06:00   DA:  0:  NARROW
*15:06:01   DA:  1:  WIDE
*15:06:02   DA:
*15:06:03   DA:YOUR CHOICE:  *DA>0
*15:06:06   DA:
*15:06:07   DA:BEAM:
*15:06:08   DA:  0:  NORMAL
*15:06:10   DA:  1:  PULSED
*15:06:11   DA:
*15:06:12   DA:YOUR CHOICE:  *DA>0
*15:06:17   DA:DIGITIZING PARAMETERS:
*15:06:18   DA:
*15:06:19   DA:BANDWIDTH:          20 KHZ.
*15:06:21   DA:GAIN:               2 MV./PA.
*15:06:23   DA:PRE-AMP:            NARROW
*15:06:25   DA:BEAM:               NORMAL
*15:06:27   DA:
*15:06:28   DA:OK?
*DA>Y (23)
*15:06:31   DA:FIRST GENERAL HEADER LINE: (24)
*15:06:33   DA:
*DA>FINAL REPORT PROGRAM TEST
*15:07:25   DA:SECOND:
*15:07:26   DA:
*DA>TUBE 107
*15:08:29   DA:THIRD:
*15:08:30   DA:
*DA>NO COOLING
*15:09:05   DA:GENERAL HEADER:
*15:09:06   DA:
*15:09:07   DA:FINAL REPORT PROGRAM TES
*15:09:09   DA:TUBE 107
*15:09:10   DA:NO COOLING
*15:09:11   DA:
*15:09:12   DA:OK?
*DA>Y (25)
*15:09:16   DA:FIRST PARTICULAR HEADER LINE: (26)
*15:09:18   DA:
*DA>FILE 1 FIRST LINE OF HEADER INFORMATION
*15:10:03   DA:SECOND:
*15:10:04   DA:
*DA>FILE 1 SECOND LINE OF HEADER INFORMATION
*15:10:24   DA:THIRD:
*15:10:25   DA:
*DA>FILE 1 THIRD LINE OF HEADER INFORMATION
```

23. Yes or No required. If listed parameters are OK, enter Yes. If you wish to change a parameter enter No.

23. Yes or No required. If listed parameters are OK, enter Yes. If you wish to change a parameter enter No.
24. Operator begins to enter three (3) lines of General Header.

25. Yes or No required. A No reply provides for re-typing the General Header just entered.
26. Operator begins to enter three (3) lines of Particular Header.

```
*15:10:40   DA:PARTICULAR HEADER:
*15:10:42   DA:
*15:10:43   DA:FILE 1 FIRST LINE OF HEADER INFORMATION
*15:10:45   DA:FILE 1 SECOND LINE OF HEADER INFORMATION
*15:10:47   DA:FILE 1 THIRD LINE OF HEADER INFORMATION
*15:10:50   DA:
*15:10:50   DA:OK?  (DIGITIZING WILL START IF YOU REPLY AFFIRMATIVELY.)
*DA>Y 27
*15:12:06   DA:2048 LINES DIGITIZED.
*15:12:07   DA: 9
*15:12:08   DA:DISC FILE: 10
*15:12:09   DA:FILE 1 FIRST LINE OF HEADER INFORMATION 11
*15:12:12   DA: 9
*15:12:13   DA:TAPE EDEN 2     FILE  1: 12
*15:12:14   DA:TEST 13
*DA>DT 28
*15:13:08   DA:THERE ARE 2048 LINES IN THE FRAME ON DISC.
*15:13:10   DA:FIRST LINE:              1
*15:13:12   DA:LAST LINE:            2048
*15:13:14   DA:OK?
*DA>Y 29
*15:13:21   DA:THE CURRENT TAPE NAME IS EDEN 2
*15:13:23   DA:ENTER A NEW ONE IF YOU WISH TO CHANGE IT.
*DA>RUTGERS 30
*15:16:20   DA:2048 LINES COPIED.
*15:16:22   DA: 9
*15:16:23   DA:DISC FILE: 10
*15:16:24   DA:FILE 1 FIRST LINE OF HEADER INFORMATION 11
*15:16:26   DA: 9
*15:16:27   DA:TAPE RUTGERS   FILE  2. 12
*15:16:29   DA: *  *  *  END OF DATA  *  *  *
*DA>MON 31
*DA>255 - 555 32
*15:18:38   DA:
*15:18:39   DA:DISC FILE:
*15:18:40   DA:FILE 1 FIRST LINE OF HEADER INFORMATION
*15:18:42   DA:
*15:18:43   DA:TAPE RUTGERS   FILE  2.
*15:18:45   DA: *  *  *  END OF DATA  *  *  *
```

27. Yes or No required. A No reply provides for changing the Particular Header information. Yes begins digitizing onto disc.
9. An intentional blank line intended to enhance the legibility of the printouts.
10. Identifies 11 as disc information.
11. First line of particular header. Will be "NONE" when the system is first turned on.
12. Identifies the name of the tape and what file is next.
13. First line of particular header information of tape. Will be blank with a new tape.
28. DT Disc to tape transfer.

29. Yes or No required. Yes will transfer all 2048 digitized lines. No results in the computer asking which lines should be transferred.

30. Operator enters the new tape name. Eight characters maximum.

10. Identifies 11 as disc information.
11. First line of particular header. Will be "NONE" when the system is first turned on.

12. Identifies the name of the tape and what file is next.
31. MON MONitor command displays the whole frame video data from the disc on the slow scan monitor.
32. Line # - Line # ; displays selected lines of video data from the disc on the slow scan monitor.

```
*DA>PA (15)
*15:21:49   DA:TASK PAUSED
*PREP 1 (17)
*15:22:04   CC:CAMERA CONTROL TASK
*15:25:25   CC:END OF CAMERA COMMAND INPUT
*15:25:27   CC:TASK PAUSED
*EX 1 (19)
*15:25:44   CC:CAMERA CONTROL TASK
*15:26:03   CC:END OF CAMERA COMMAND INPUT
*15:26:05   CC:TASK PAUSED
*T DA (20)
*CO (21)
*DA>DIG (22)
*15:26:31   DA:DIGITIZING PARAMETERS:
*15:26:33   DA:
*15:26:33   DA:BANDWIDTH:            40 KHZ.
*15:26:35   DA:GAIN:                 1 MV./PA.
*15:26:37   DA:PRE-AMP:              NARROW
*15:26:39   DA:BEAM:                 NORMAL
*15:26:41   DA:
*15:26:42   DA:OK?
*DA>Y (23)
*15:26:45   DA:GENERAL HEADER:
*15:26:46   DA: (9)
*15:26:47   DA:FINAL REPORT PROGRAM TEST
*15:26:49   DA:TUBE 107
*15:26:50   DA:NO COOLING
*15:26:51   DA:(9)
*15:26:52   DA:OK?
*DA>Y (25)
*15:26:57   DA:FIRST PARTICULAR HEADER LINE:
*15:26:59   DA:
*DA>FILE 2 FIRST LINE OF PARTICULAR HEADER
*15:27:59   DA:SECOND:
*15:28:00   DA:
*DA>FILE 2 SECOND LINE OF PARTICULAR HEADER
*15:28:24   DA:THIRD:
*15:28:25   DA:
*DA>FILE 2 THIRD LINE OF PARTICULAR HEADER
*15:28:59   DA:PARTICULAR HEADER:
*15:29:00   DA:
*15:29:01   DA:FILE 2 FIRST LINE OF PARTICULAR HEADER
*15:29:03   DA:FILE 2 SECOND LINE OF PARTICULAR HEADER
*15:29:06   DA:FILE 2 THIRD LINE OF PARTICULAR HEADER
*15:29:08   DA:
*15:29:09   DA:OK?  (DIGITIZING WILL START IF YOU REPLY AFFIRMATIVELY.)
*DA>Y (27)
*15:30:23   DA:2048 LINES DIGITIZED.
*15:30:24   DA:
*15:30:25   DA:DISC FILE:
*15:30:26   DA:FILE 2 FIRST LINE OF PARTICULAR HEADER
*15:30:29   DA:
*15:30:29   DA:TAPE RUTGERS   FILE  2.
*15:30:31   DA: *  *  *  END OF DATA  *  *  *
*DA>DT (28)
*15:30:44   DA:THERE ARE 2048 LINES IN THE FRAME ON DISC.
*15:30:46   DA:FIRST LINE:             1
*15:30:48   DA:LAST LINE:           2048
*15:30:49   DA:OK?
*DA>N (29)
*15:30:53   DA:TYPE THE NUMBER OF THE FIRST LINE YOU WANT:
*DA>367
*15:31:00   DA:... AND THE SECOND:
*DA>569
*15:31:08   DA:FIRST LINE:           367
```

15. PA Pauses the DA task.

17. PREP 1 Commands Prepare 1 recipe.

19. EX (time) Begins an exposure, time in seconds.

20. T DA Identifies the next task as a data task.
21. CO COntinue a task which had been paused.
22. DIG Command to enter digitizing mode.

23. Yes or No required. If listed parameter are OK, enter Yes. If you wish to change a parameter enter No.
9. An intentional blank line intended to enhance the legibility of the printouts.

25. Yes or No required. A No reply provides for re-typing the General Header just entered.

27. Yes or No required. A No reply provides for changing the Particular Header information. Yes begins digitizing onto disc.

28. DT Disc to tape transfer.

29. Yes or No required. Yes will transfer all 2048 digitized lines.

```
*15:31:10   DA:LAST LINE:              569
*15:31:12   DA:OK?
*DA>N  29
*15:31:15   DA:TYPE THE NUMBER OF THE FIRST LINE YOU WANT:
*DA>200
*15:31:22   DA:... AND THE SECOND:
*DA>300
*15:31:27   DA:FIRST LINE:             200
*15:31:29   DA:LAST LINE:              300
*15:31:31   DA:OK?
*DA>Y
*15:31:34   DA:THE CURRENT TAPE NAME IS RUTGERS
*15:31:36   DA:ENTER A NEW ONE IF YOU WISH TO CHANGE IT.
*DA>
*15:31:47   DA: 101 LINES COPIED.
*15:31:49   DA:
*15:31:50   DA:DISC FILE:
*15:31:51   DA:FILE 2 FIRST LINE OF PARTICULAR HEADER
*15:31:53   DA:
*15:31:54   DA:TAPE RUTGERS   FILE  3.
*15:31:56   DA: *  *  *  END OF DATA  *  *  *
*DA>MON 31
*DA>PA  15
*15:32:53   DA:
*15:32:54   DA:DISC FILE:
*15:32:55   DA:FILE 2 FIRST LINE OF PARTICULAR HEADER
*15:32:58   DA:
*15:32:58   DA:TAPE RUTGERS   FILE  3.
*15:33:00   DA: *  *  *  END OF DATA  *  *  *
*15:33:02   DA:TASK PAUSED

*T DA  20
*CO  21
*DA>FILE 1  33
*15:34:17   DA:
*15:34:18   DA:TAPE RUTGERS   FILE  1:
*15:34:19   DA:FILE 1 FIRST LINE OF HEADER INFORMATION
*DA>T H     34
*15:34:37   DA:
*15:34:38   DA:TAPE RUTGERS   FILE  1:
*15:34:40   DA:FILE 1 FIRST LINE OF HEADER INFORMATION
*15:34:42   DA:
*15:34:43   DA:TAPE RUTGERS   FILE  1:
*15:34:44   DA:03/18/77  15:10:57
*15:34:46   DA:FINAL REPORT PROGRAM TEST
*15:34:48   DA:TUBE 107
*15:34:49   DA:NO COOLING
*15:34:50   DA:FILE 1 FIRST LINE OF HEADER INFORMATION
*15:34:52   DA:FILE 1 SECOND LINE OF HEADER INFORMATION
*15:34:55   DA:FILE 1 THIRD LINE OF HEADER INFORMATION
*15:34:57   DA:FIRST LINE:             1
*15:34:59   DA:LAST LINE:              2048
*15:35:00   DA:LINE LENGTH:            2048 PIXELS
*15:35:02   DA:PREPARE-CYCLE FILE:     1
*15:35:04   DA:BURST-MODE FILE:        WHAT?  BURSTS?
*15:35:06   DA:BANDWIDTH:              20 KHZ.
*15:35:08   DA:GAIN:                   2 MV./PA.
*15:35:10   DA:PRE-AMP:                NARROW
*15:35:12   DA:BEAM:                   NORMAL
*DA>D H   35
*15:35:23   DA:
*15:35:23   DA:DISC FILE:
*15:35:25   DA:FILE 2 FIRST LINE OF PARTICULAR HEADER
*15:35:27   DA:
*15:35:28   DA:DISC FILE:
```

29. Yes or No required. Yes will transfer all 2048 digitized lines. No results in the computer asking which lines should be transferred.

31. MON MONitor command displans the whole frame video data from the disc on the slow scan monitor.
15. PA Pauses the DA task.

20. T DA Identifies the next task as a data task.
21. CO COntinue a task which had been paused.
33. FILE # Moves tape to designated file.

34. T H Displays tape header information.

35. D H Displays disc header information.

```
*15:35:29   DA:NEW FRAME
*15:35:30   DA:03/18/77  15:29:18
*15:35:32   DA:FINAL REPORT PROGRAM TESR
*15:35:33   DA:TUBE 107
*15:35:34   DA:NO COOLING
*15:35:36   DA:FILE 2 FIRST LINE OF PARTICULAR HEADER
*15:35:38   DA:FILE 2 SECOND LINE OF PARTICULAR HEADER
*15:35:40   DA:FILE 2 THIRD LINE OF PARTICULAR HEADER
*15:35:42   DA:FIRST LINE:              1
*15:35:44   DA:LAST LINE:             2048
*15:35:46   DA:LINE LENGTH:           2048 PIXELS
*15:35:48   DA:PREPARE-CYCLE FILE:    1
*15:35:49   DA:BURST-MODE FILE:       WHAT?  BURSTS?
*15:35:52   DA:BANDWIDTH:             40 KHZ.
*15:35:53   DA:GAIN:                  1 MV./PA.
*15:35:55   DA:PRE-AMP:               NARROW
*15:35:57   DA:BEAM:                  NORMAL
*DA>TD  36
*15:38:17   DA:2048 LINES COPIED.
*15:38:19   DA:
*15:38:19   DA:DISC FILE:
*15:38:21   DA:FILE 1 FIRST LINE OF HEADER INFORMATION
*15:38:23   DA:
*15:38:24   DA:TAPE RUTGERS   FILE  2:
*15:38:25   DA:FILE 2 FIRST LINE OF PARTICULAR HEADER
*DA>D H  35
*15:38:33   DA:
*15:38:33   DA:DISC FILE:
*15:38:35   DA:FILE 1 FIRST LINE OF HEADER INFORMATION
*15:38:37   DA:
*15:38:38   DA:DISC FILE:
*15:38:39   DA:TAPE RUTGERS   FILE  1:
*15:38:41   DA:03/18/77  15:10:57
*15:38:42   DA:FINAL REPORT PROGRAM TEST
*15:38:44   DA:TUBE 107
*15:38:45   DA:NO COOLING
*15:38:46   DA:FILE 1 FIRST LINE OF HEADER INFORMATION
*15:38:48   DA:FILE 1 SECOND LINE OF HEADER INFORMATION
*15:38:51   DA:FILE 1 THIRD LINE OF HEADER INFORMATION
*15:38:53   DA:FIRST LINE:              1
*15:38:55   DA:LAST LINE:             2048
*15:38:57   DA:LINE LENGTH:           2048 PIXELS
*15:38:59   DA:PREPARE-CYCLE FILE:    1
*15:39:00   DA:BURST-MODE FILE:       WHAT?  BURSTS?
*15:39:02   DA:BANDWIDTH:             20 KHZ.
*15:39:04   DA:GAIN:                  2 MV./PA.
*15:39:06   DA:PRE-AMP:               NARROW
*15:39:08   DA:BEAM:                  NOPMAL
*DA>MON  31
*DA>PA   15
*15:39:36   DA:
*15:39:36   DA:DISC FILE:
*15:39:38   DA:FILE 1 FIRST LINE OF HEADER INFORMATION
*15:39:40   DA:
*15:39:41   DA:TAPE RUTGERS   FILE  2:
*15:39:42   DA:FILE 2 FIRST LINE CF PARTICULAR HEADER
*15:39:45   DA:TASK PAUSED
*PREP 1  17
*15:41:10   CC:CAMERA CONTROL TASK
*T DA  20
*CO  21
*DA>SK  37   multi task operation [illegible]
*15:41:54   DA:
*15:41:55   DA:TAPF RUTGERS   FILE  3.
*15:41:56   DA: *  *  *  END OF DATA  *  *  *
*DA>PA  15
```

36. TD Tape to disc transfer.

35. D H Displays disc header information.

31. MON MONitor command displays the whole frame video data from the disc on the slow scan monitor.
15. PA Pauses the DA task.

17. PREP 1 Commands Prepare 1 recipe.
20. T DA Identifies the next task as a data task.
21. CO COntinue a task which had been paused.
37. SK Tape skips forward to end of data.

15. PA Pauses the DA task, returns to operating system.

```
*15:42:26   DA:TASK PAUSED
*15:44:32   CC:END OF CAMERA COMMAND INPUT
*15:44:34   CC:TASK PAUSED
*ZEXOFF 38
*15:44:52   CC:CAMERA CONTROL TASK
*15:45:08   CC:END OF CAMERA COMMAND INPUT
*15:45:10   CC:TASK PAUSED
*T DA 20
*CO 21
*DA>DIG 22
*15:45:32   DA:DIGITIZING PARAMETERS:
*15:45:34   DA:
*15:45:34   DA:BANDWIDTH:            40 KHZ.
*15:45:36   DA:GAIN:                 1 MV./PA.
*15:45:38   DA:PRE-AMP:              NARROW
*15:45:40   DA:BEAM:                 NORMAL
*15:45:42   DA:
*15:45:43   DA:OK?
*DA>Y 23
*15:45:46   DA:GENERAL HEADER:
*15:45:47   DA:
*15:45:48   DA:FINAL REPORT PROGRAM TEST
*15:45:50   DA:TUBE 107
*15:45:51   DA:NO COOLING
*15:45:52   DA:
*15:45:53   DA:OK?
*DA>Y 25
*15:45:58   DA:FIRST PARTICULAR HEADER LINE:
*15:45:59   DA:
*DA>ZERO EXPOSURE:FIRST LINE OF PARTICULAR HEADER
*15:46:45   DA:SECOND:
*15:46:47   DA:
*DA>SECOND LINE OF PARTICULAR HEADER
*15:47:06   DA:THIRD:
*15:47:07   DA:
*DA>THIRD LINE OF PARTICULAR HEADER
*15:47:19   DA:PARTICULAR HEADER:
*15:47:21   DA:
*15:47:21   DA:ZERO EXPOSURE:FIRST LINE OF PARTICULAR HEADER
*15:47:24   DA:SECOND LINE OF PARTICULAR HEADER
*15:47:26   DA:THIRD LINE OF PARTICULAR HEADER
*15:47:28   DA:
*15:47:29   DA:OK?  (DIGITIZING WILL START IF YOU REPLY AFFIRMATIVELY.)
*DA>Y 27
*15:48:43   DA:2048 LINES DIGITIZED.
*15:48:44   DA:
*15:48:45   DA:DISC FILE:
*15:48:46   DA:ZERO EXPOSURE:FIRST LINE OF PARTICULAR HEADER
*15:48:49   DA:
*15:48:50   DA:TAPE RUTGERS   FILE  3.
*15:48:51   DA: *  *  *  END OF DATA  *  *  *
*DA>DT 28
*15:49:04   DA:THERE ARE 2048 LINES IN THE FRAME ON DISC.
*15:49:06   DA:FIRST LINE:            1
*15:49:08   DA:LAST LINE:             2048
*15:49:10   DA:OK?
*DA>Y 29
*15:49:18   DA:THE CURRENT TAPE NAME IS RUTGERS
*15:49:20   DA:ENTER A NEW ONE IF YOU WISH TO CHANGE IT.
*DA>
*15:51:19   DA:2048 LINES COPIED.
*15:51:21   DA:
*15:51:22   DA:DISC FILE:
*15:51:23   DA:ZERO EXPOSURE:FIRST LINE OF PARTICULAR HEADER
*15:51:26   DA:
*15:51:26   DA:TAPE RUTGERS   FILE  4.
```

38. ZEXOFF Commands a zero exposure with the tube heater off.

20. T DA Identifies the next task as a data task.
21. CO COntinue a task which had been paused.
22. DIG Command to enter digitizing mode.

23. Yes or No required. If listed parameters are OK, enter Yes. If you wish to change a parameter enter No.

25. Yes or No required. A No reply provides for re-typing the General Header just entered.

27. Yes or No required. A No reply provides for changing the Particular Header information. Yes begins digitizing onto disc.

28. DT Disc to tape transfer.

29. Yes or No required. Yes will transfer all 2048 digitized lines No results in the computer asking which lines should be transferred.

```
*15:51:28   DA: *  *  *  END OF DATA  *  *  *
*DA>RM 34
*15:53:03   DA:
*15:53:04   DA:TAPE RUTGERS   FILE  1:
*15:53:05   DA:FILE 1 FIRST LINE OF HEADER INFORMATION
*DA>PA 15
*15:53:11   DA:TASK PAUSED
*BYE 40
*15:53:20   CC:END OF TASK   255
*15:53:21   DA:END OF TASK   255
*MA RD:,OFF 41
*D D 42
NAME  DN KEYS
NULL   0 0000
CRT   10 FFFF
T     85 0000
TV    8B 0000
FD    C7 0000   OFF
RD    C6 0000   OFF
T1    C5 0000
*
```

34. T H Displays tape header information.

15. PA Pauses the DA task.

40. BYE Ends DA and CC tasks.

41. Operator marks removable disk OFF line.
42. DD Display devices. FD (fixed disc) and RD (removable disc) must both be OFF before it is safe to shut down the system.

Section 110 70-mm SEC Sensor Tests, PTS Acceptance Test

The acceptance test of the PTS consisted of testing a 70-SEC sensor to the specifications detailed in Appendix A of the Statement of Work (Section 131). Westinghouse sensor W 25 (No. 77-08-949) was the first tube to be tested with the data gathered being analyzed using Princeton's IBM 360-91 computer. While this particular sensor exhibited some problems, the PTS satisfactorily performed its PREPARE, EXPOSE, and READOUT (DIGITIZE) tasks.

The full test report on W 25 consists of about 100 pages of text and data. A preliminary copy of the full report has been furnished to GSFC. A full, improved version of this report will be included in the final report for GSFC contract NAS5-23387.

Here, in Sections 111 through 114, a description is given of the tests performed on W 25. An abridged discussion of the test results is presented in Section 135.

Section 111 Target Response and Uniformity Tests (A-3) of Work Statement

1. A standard exposure, E_f, was arrived at for test purposes, such that the knee of the transfer curve is just reached at that exposure. This is an approximate exposure: a range of exposures is used in the photorun to be sure the full transfer curve is known. E_f is arrived at by exposing at various light levels, each two times the previous one in exposure time (constant light intensity), until a factor 2 increase in total exposure causes only a 50% increase in tube output.
2. The photometric test pattern (PTP) (Figure 111), consisting of twenty-one (21) apertures; is imaged onto the photocathode, so the projected hole size is 2.3mm. Exposures are made in the sequence 0, 1/32, 1/16, 1/8, 1/4, 1/2, 1, 2, 4, 0 times E_f. These data are analyzed in 50 x 50 pixel patches to derive transfer curves and noise statistics for each hole location. The PTP was designed to provide test data over 90% of the tube area. For W 25, the optical reduction of the test chart was larger than desired, so 80% of the tube area is tested, corresponding to 90% in linear dimensions. The behavior of the outer regions can be evaluated from flat field exposures made for each tube.
3. 3 Flat field exposures were made for fixed pattern noise evaluation and for uniformity tests.

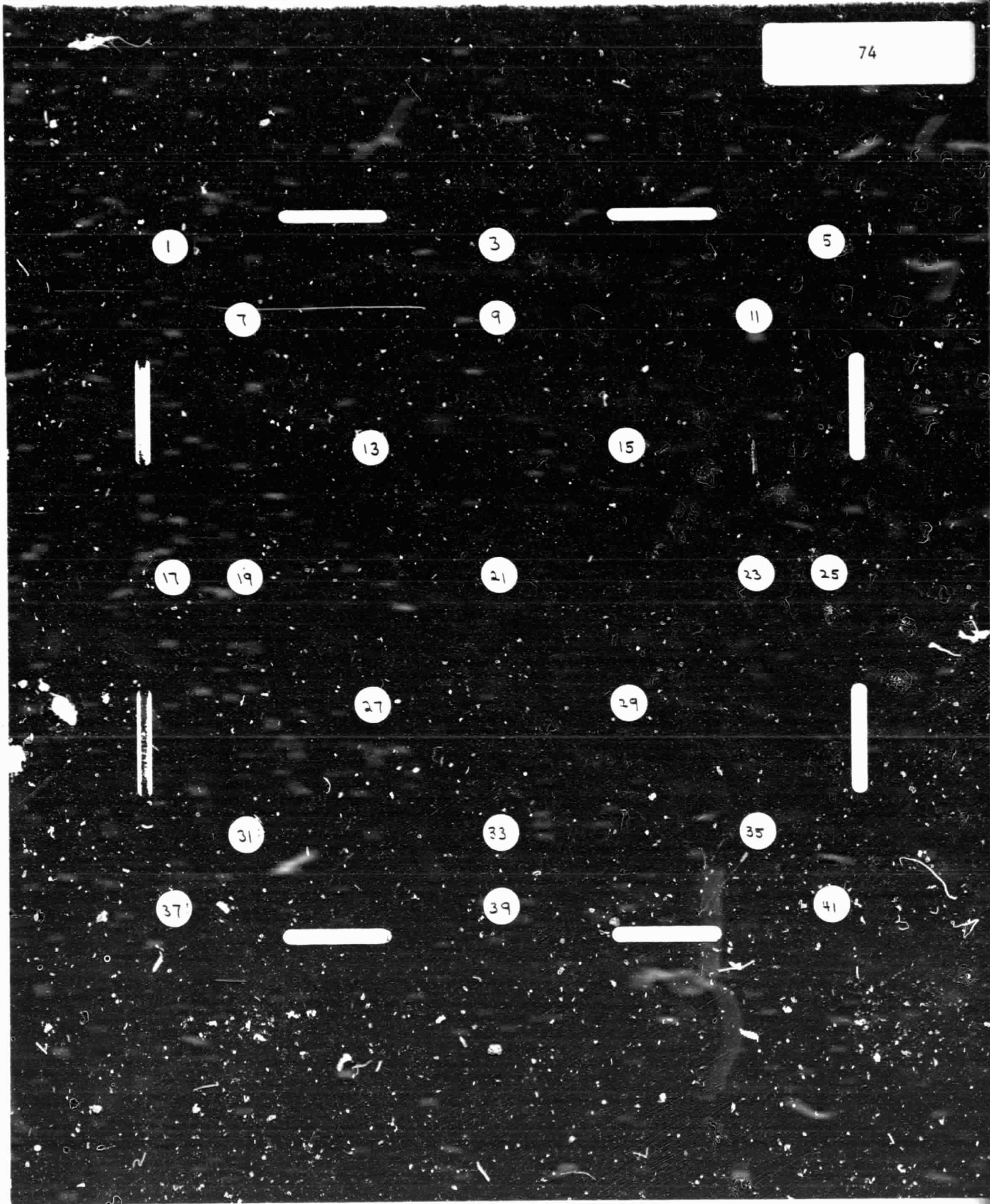


Figure 111

The photometric test pattern. The image shown is about three (3) times the size as projected on the tube face. The long slots are used for aligning the pattern with the target edges.

Section 112 Integration Tests (A-4) of Work Statement

Image Section Background (ISB)

The image section of the tube produces various "dark emissions", such as photocathode dark current, which limit the useful exposure time. To estimate the useful exposure time for testing each tube, a 15 min. integration is done at room temperature with the photocathode on, but gun heater off. No light enters the tube. This exposure is digitized, and can be played back through the PTS scan converter and oscilloscope for examination of selected lines. If a sensor produces low ISB (examined lines show ISB < 10% of E_f in 15 min.), a long integration of 2 hours is taken. If the temperature exposure shows ISB >10% of E_f in 15 min., an appropriately shorter exposure is made. For W 25, a 30 min. ISB integration was done -20°C, and a 16 hour integration was done at -20°C, but cooling failed overnight and the room temperature dark current completely saturated the tube.

Section 113 Storage and Square Wave Amplitude Response Tests

The SEC target can store an image for only finite periods of time. The resolution is limited by the electromagnetic optics of the image section, the target grain, and the electron beam size used for readout. Resolution was evaluated for W 25 using a test pattern from the 35 mm tube tests (shown in Sec n 135). Storage was evaluated by comparing a reference exposure with this resolution test pattern, which was readout immediately, with an identical exposure (2 sec, white light) which was read out two hours later. For W25, the reference frames for the storage tests can be used to evaluate resolution. Note that while a square wave pattern isused, the optics which focus the pattern onto the tube face are not perfect at 10 lp/mm, so that the tube actually sees a more nearly sine wave pattern.

Section 114 Distortion Tests

Distortion can be measured from pictures made of the full frame exposures of the resolution test pattern for tube W 25, as the pattern has both vertical and horizontal straight lines.

Section 120 Assessment and Recommendations

The Parametric Test Set (PTS) is, as expected, vital to the detailed analysis of the SEC sensor performance. It is found to be adequate for all the testing required in the present SEC sensor development work being performed under NAS5-23387.

The mean time to failure of the system is a minor problem, especially with the computer and its peripherals. This is perhaps to be expected with a new system. And we can report that the down time is decreasing with use. The software has turned out to be relatively trouble free. We do find it necessary to call on the software engineer in some instances when the system computer fails. As the OBSCAM observing camera system is similar to the PTS, we have been able to diagnose problems with the PTS hardware by swapping components such as the Disc Recorder and Tape Recorder.

In terms of improvements to the PTS, it would be very useful to add a scan converter similar to the one in OBSCAM. This 300 x 300 pixel solid state memory and display would allow faster and more efficient analysis of certain performance characteristics such as resolution and fixed pattern noise in the SEC target or electrical noise in the system. As it stands now the image at full fidelity can only be examined with glossy prints made on the film scanner. The cost of adding the OBSCAM scan converter to PTS would be about $15,000.

Section 130 APPENDICES

Section 131	Gives the details of the Statement of Work that governed this program.
Section 132	Glossary of the signal nomenclature used in the System Signal Diagrams.
Section 133	Details the signal flow in the camera electronics.
Section 134	Details the specification for the Light Source and Image Projector.
Section 135	Excerpts from the W25 sensor test report.
Section 136	Listing the referenced publications noted in Section 40.
Section 137	Bibliography of astronomical papers based on SEC Camera observations.

Section 131

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

GODDARD SPACE FLIGHT CENTER

STATEMENT OF WORK

FOR

SECONDARY ELECTRON CONDUCTION TUBE PARAMETRIC TEST AND EVALUATION SYSTEM

OCTOBER 1975

PCN: 604-73431

TABLE OF CONTENTS

(cont.)

1.0 PURPOSE

This Statement of Work describes the design, fabrication and testing of a Parametric Test and Evaluation System to be developed in support of the SEC Orthicon Camera (SECO) Development Program. The SECO Development Program assumes the availability of optimized SECO tubes that have undergone severe parametric analysis for establishing controlled fabrication procedures. The design, fabrication and testing of the laboratory Parametric Test and Evaluation System performed under this Statement of Work is intended to provide the necessary automated hardware required to develop the optimized SEC tube.

2.0 SCOPE

This Statement of Work encompasses only the design, fabrication and testing of the Parametric Test and Evaluation System and does not include any development or testing of SEC tubes.

3.0 PROGRAM MANAGEMENT

3.1 Organization Requirements

The contractor shall provide NASA with a chart of those persons assigned responsibility for the Work Statement. In conjunction with this chart, the contractor shall identify by name and experience level the project engineer or Program Manager assigned the responsibility for each major task and deliverable end item. Prior to diverting any

of the specific personnel, the contractor shall notify the NASA Contracting and Technical Officers and provide sufficient data on the proposed replacement to permit NASA review to ensure equivalent professional qualifications.

3.2 Program Plan Requirements

The contractor shall prepare and submit to NASA for approval a Program Plan within 15 days from the date of contract award. This plan shall be the single, authoritative summary document which the contractor shall use to delineate the manner in which the objectives of this Work Statement shall be achieved. It shall include, as a minimum, a description of planned activities for each identifiable requirement in the Work Statement. The plan shall use flow diagrams and other similar means to reduce the amount of verbal descriptive material. This plan shall include the method of procurement, procurement schedules, and procedures by which control will be exerc... over any subcontract effort. This plan shall be assigned an exhibit number and become a part of the Statement of Work after it has been approved by NASA.

4.0 <u>PROGRAM CONTROL REQUIREMENTS</u>

4.1 Conference Requirements

Bi-monthly review conferences shall be held at GSFC commencing two months after date of contract. These conferences shall be attended by the contractor's Program Manager and appropriate Government

personnel. They shall consist of a detailed review of the progress of the program, a discussion of problem areas and recommended solutions, and the submission of a revised program plan when necessary.

4.2 Schedule Requirements

Program Evaluation Review Technique (PERT) will be used by NASA for visibility of the total project. The contractor shall submit with the Program Plan a project PERT for NASA's approval. It shall provide the logic flow for the design, fabrication, and testing of the Parametric Test and Evaluation System. The events shall be sufficient in density to depict the contractor's planning, implementation, and other major milestone information that, in the opinion of NASA, clearly indicates the contractor's plan for accomplishing the Work Statement requirements. It is necessary that the density of events be such that no major activity is unreported upon for more than one month. For purposes of clarity, the contractor shall provide a brief description of each PERT event and activity. The description and number assignments, once established, shall not be changed without prior notification to NASA. The Program Plan and PERT can be combined into one document.

5.0 TECHNICAL REQUIREMENTS

5.1 General

All design and fabrication of the Parametric Test and Evaluation System performed under this Statement of Work shall be directed toward developing a semi - automated performance evaluation testing system compatible

with the 70mm SEC Camera used under NASA contract NAS 5-20833 for testing the 70mm SEC tube presently designated as the Westinghouse WX-32193. The contractor shall design, fabricate, and evaluate a test apparatus which shall be capable of performing the tests outlined in Appendix A, and which shall operate in an semi-automatic data acquisition, and control mode. Data analysis of raw data tapes may be performed on a general purpose computer.

5.2 System Engineering Requirements

The contractor shall prepare the overall system performance design requirements specifications for the test apparatus within the constraints given in Paragraph 5.1 as are required to successfully carry out the system engineering task.

5.2.1 Functional Flow Block Diagrams

The contractor shall specify and sequence the system and subsystem functions that must be accomplished in order to achieve system project objectives through the use of Functional Flow Block Diagrams.

5.2.2 Functional Flow Block Diagram Data

With each Functional Flow Block Diagram, the contractor shall define the requirements and constraints pertaining to each of the flow diagram functions and apportion these requirements to equipment, programs, etc.

5.2.3 Schematic Block Diagrams

The contractor shall provide the Schematic Block Diagrams which

identify and represent hardware, and computer program subsystem/component functional interfaces and interrelationships, as are required to successfully complete the design task.

5.2.4 Design Data

The contractor shall identify the hardware and computer program and system performance design and test requirements on an end item basis.

5.3 Design Requirements

The contractor shall define in detail the characteristics of the concepts and theories emanating from the Systems Engineering effort. For each subsystem, component and computer program, the contractor shall specify the detailed design requirements. Any restrictions of design criteria shall be identified. The conditions under which this equipment is to operate and the performance and the detailed characteristics of the equipment shall be clearly specified. Concepts shall be definitized to the point where Final Specifications, Test Plans, and Operational Plans can be prepared.

5.3.1 Design Plans and Drawings

In conjunction with the generation of Plans specified in Paragraph 5.3, the contractor shall provide a set of drawings which should evolve as an output of the design requirements, that are adequate for Princeton or their subcontractors to manufacture or purchase the equipment.

5.4 Test Requirements

The contractor shall conduct testing on a 70mm SEC tube per Appendix A to verify the performance/design requirements specified by the contract end item specification are met. The measured uniformity of the light source shall also be provided.

5.5 Schedule

The period of performance for this effort shall be nine months.

6.0 REPORTING REQUIREMENTS

In addition to the conference requirements stipulated in Paragraph 4.1, the following documentation is required: Monthly Reports, Final Report, Manufacturing Drawings Specifications and Procedures for fabrication of Hardware developed under this Statement of Work, Computer Program Documentation, System Operation and Maintenance Manuals. Reporting shall be based on the following guidelines:

6.1 Monthly Reports

The monthly reports shall include and not be limited by the following topics:

- Work flow chart for Parametric Test and Evaluation System design, fabrication and test tasks.
- Manpower Cost expenditures to date and projection to contract completion.
- Results and action items resulting from meetings during that reporting period.
- Status of system design task including technical accomplishments and problem areas.
- Status of system fabrication task including technical accomplishments and problem areas.
- Status of system testing task including technical accomplishments and problem areas.

The above status reports shall include where applicable and not be limited by: design development including flow diagrams, design data, etc.; hardware development including fabrication and procurement status, system evaluation status including test data on system/subsystem performance.

6.2 Manufacturing Drawings, Specifications and Procedures Report

This report shall include and not be limited by any and all system/subsystem/element drawings and specifications generated under this Statement of Work essential to the fabrication of the system hardware. It shall specify where applicable the manufacturing procedures required for fabrication of the hardware. It is intended that this report shall be in sufficient detail so as to enable a duplicate system to be built, by a group containing skills comparable to Princeton University from this data without requiring additional system design or manufacturing

drawings.

6.3 Computer Program Documentation

The contractor shall provide Computer Program Documentation that shall include but not be limited by the program listing, a description of theprogram function, operation, data input and output format, logistics and flow chart. It shall also contain all analyses leading to the end results of related theoretical derivations.

6.4 System Operation and Maintenance Manuals

The contractor shall provide the system operation and maintenance manuals that accompany purchased subsystems, adequate electrical drawings shall be developed to trouble shoot any interface electronic circuits. The contractor shall provide a description of the camera configuration state for each test sequence (tabular form is sufficient) employed for testing tubes per Appendix A.

6.5 Final Report

The contractor shall prepare a final report in accordance with the requirements of GSFC Specification S-250-P-IC, March 1972, entitled, "Contractor Prepared Monthly Periodic, and Final Reports" incorporated herein by reference. The Final Report shall include but not be limited by the following: summary of each contract task including a coherent formulation of the program development and final results; summary of test and evaluation of the performance of the hardware test set developed under this Statement of Work including a tabular summary documentation of the tests and their results.

6.6 Miscellaneous Publications

The contractor shall provide the Technical Officer copies of any technical papers, thesis, etc. prepared as a result of work performed under this contract.

7.0 GOVERNMENT FURNISHED EQUIPMENT

The contractor shall specify his requirements for utilization of Government equipment to the extent that his needs are clearly understood by the NASA Technical Officer.

DELIVERY SCHEDULE AND PLACE OF DELIVERY

The items set forth shall be delivered as follows:

ITEM	DESCRIPTION	QUANTITY	PLACE	DELIVERY DATE
1	Monthly Status	10	GSFC	15th of succeeding month
2	Final Report	50	GSFC	NLT 10 months ADC
3	Manufacturing Drawings	50	GSFC	NLT 10 months ADC
4	Computer Program Documentation	50	GSFC	NLT 10 months ADC
5	System Operation and Maintenance Manuals	3	GSFC	NLT 10 months ADC
6	Parametric Test & Evaluation System	1	P.U.	NLT 10 months ADC as Government furnished equipment for completing the requirements of PR 604-73427

A reproducible master of items 2, 3, and 4 shall be be delivered NLT 10 months ADC.

The following is a description of tests to be performed on the 70mm SEC tube currently designated as the Westinghouse WX-32193 using the Performance Evaluation and Test System to be developed under this Statement of Work. The test system shall be capable of and not limited to performing the following tests:

A-3 Target Response and Uniformity

The tubes are exposed for 0.0, 0.03125, 0.0625, 0.125, 0.25, 0.050, 1.0, and 2.0 times the nominal full exposure at S_{max}. Two exposures are made at each exposure level.

The digitized data are computer processed and results analyzed for the following:

A-3.1 Tube Transfer Characteristic

Average tube transfer characteristic as a function of exposure level for the central 80% region of the tube, the edges and corners.

A-3.2 Central RMS Noise

Central pixel to pixel RMS noise for 25, 50, 100, and 200μ square pixels for all exposure levels.

A-3.3 Edge and Corner RMS Noise

Edge and corner pixel to pixel RMS noise for 25, 50, 100, and 200μ square pixels for 0.25, and 1.0 times reference exposure.

A-3.4 Fixed Pattern Noise

Central and corner regions fixed pattern noise check by digitally subtracting frame-to-frame responses and resulting with a $\leq$ 2 increase in pixel-to-pixel noise, for 50μ square

pixels.

A-3.5 Average Tube Response

Map of tube response for 250μ square pixels for 0.25 and 1.0 exposure levels.

A-4 Integration Time

The tube is turned on with zero exposure level for a two hour continuous time duration. The tube is then read out to determine if the background in any of the pixels exceeds 20% of the saturation level. This test is performed as a function of photocathode temperature for the temperature values -20°C, 0°C, and +23°C.

A-5 Hold Time

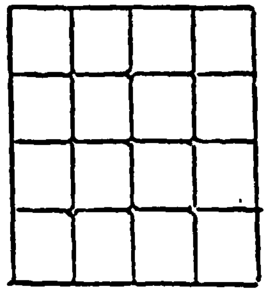
The tube is exposed with a step function target square wave for the two states: zero exposure level and full linear exposure level. The signal is then read out and stored as 25 micron square pixel data.

The tube is exposed again as above. The signal is stored for two hours before readout. The data is presented as percentage change in zero exposure level, percentage change in full exposure level and percentage change in square wave amplitude peak-to-peak response. The test is repeated for a 10 hour storage time.

A-6 Square Wave Amplitude Response (SWAR)

Tests shall be performed for exposure levels of 0.5 and 1 times

reference exposure. Define 10% response as the peak-to-peak response at 1 lp/mm. The tube is exposed using a variable square wave frequency target for the range 1 lp/mm to 30 lp/mm. The test pattern should repeat nominally 10 times across the face of the tube. The SWAR as a function of frequency for each exposure level is determined at nine points as figured below:



For each SWAR average over 16 (nominal) lines of readout.

A-7 Lag

The tube is exposed for $\geq$ 1.0 times the reference exposure. For each exposure, the tube is read out and stored as 25 micron pixel data. The tube is read out repeatedly until a baseline (no change in readout signal level) is obtained. The data is presented as:

$$\text{PERCENTAGE LAG} = \frac{\left(\sum_{i=1}^{K} P_i\right) - P_1}{\sum_{i=1}^{K} P_i} \times 100$$

Where P_i is the pixel signal level of the i^{th} readout, i = 1, 2...,K where P_k is the pixel signal level for baseline.

A-8 Interference

A test shall be performed to determine if an interference pattern is introduced by the MgF_2/photocathode combination.

Section 132 Glossary of Mnemonics (Signal Name Abbreviations)

Mnemonics	Origin-Sheet No.	Meaning
ACTCOMM	8	Action Command
ADCLDISAB	18	Address Clock Disable
ADD/A	18	Address D/A
ADDIGBUR	18	A/D Digitize, Burst
ADDIGN	18	A/D Digitize, Normal
ADDR	19	Address for ULI1 from Computer
ADFR	18	Address Frame Command (Playback)
ALIGN A HI	6	Alignment Coil A, current input
ALIGN A LO	6	Alignment Coil A, current return
ALIGN B HI	6	Alignment Coil B, current input
ALIGN B LOW	6	Alignment Coil B, current return
ALIGN I_A TLM	6	Alignment Current Telemetry, Coil
ALIGN I_B TLM	6	Alignment Current Telemetry, Coil B
AST	8	A Strobe (Action Command Strobe)
AUTO	8	Automatic, Computer Mode

Mnemonics	Origin-Sheet No.	Meaning
BCL	12	Beam Clear (sets beam to OFF)
BHI	11	Beam Hi
BHIC	10	Beam Hi Command
BON	11	Beam On
BONC	10	Beam On Command
BONP	11	Beam On Processed
BST	8	B Strobe (Function Command Strobe)
BUSY	21	Busy (Camera to ULI)
BUSY1	2	Busy 1 (during playback-electronics not ready for new data from computer)
BUSYCAM	19	Busy Camera (ULI to Camera)
BWCL	12	Bandwidth Clear (sets bandwidth to 40 kHz)
BWDØ	11	Bandwidth, Bit 0
BWD1	11	Bandwidth, Bit 1

Mnemonics	Origin-Sheet No.	Meaning
C	14	Clock (2 mHz)
CALP	16	Calibration Pulse
CL	21	Clock
CLx2	14	Clock Times Two
CLAMP	6	Clamp
CLBUR	21	Clock, Burst (for BURST mode digitizing)
CLBUSY	20	Clock Busy
CLDA	20	Clock D/A
CLDISAB	18	Clock Disable
CLDISABR	18	Clock Disable Burst
CLEAR	3	Clear
CL6ØHZ	15	Clock, 60 HZ
CL6ØHZP	15	Clock, 60 Hz Processed
CLOCK	3	Clock (CLDA + CL Test 1)
CLR	11	Clear
CLRD	4	Clock Read
CLTEST 1	4	Clock Test 1
CMD/A	18	Command D/A
CMDIGBUR	18	Command Digitize Burst
CMDIGN	18	Command Digitize Normal
CMDIGN/DIGBUR	18	Command Digitize Normal or Burst
CMDIGN/DIGBUR/DA	18	Command Digitize Normal or Burst or D/A
CMDNACC	12	Command Not Accepted

Cs continued on next page

Mnemonics	Origin-Sheet No.	Meaning
CMF	18	Command Frame
CMGB	8	Command Gate B
CMP		Lines From/To Computer
COTØX	18	Command Out x (ULI to Camera)
COUNT	17	Count
CS	14	Conversion Sync (NORMAL mode digitizing clock)
$CS_{/LDC}$	14	Conversion Sync for Line Drive Count
CSN	10	Continuous Scan
CSNEND	12	Continuous Scan End
CSNEX	15	Continuous Scan Expose

Mnemonics	Origin-Sheet No.	Meaning
DA	4	D/A
D_x	3	Data, Bi-directional (ULI-Camera)
DAD_n	2	Data A/D n
DAGB	8	Data Available Gate B
DALATCH	4	D/A Latch
DALED	4	D/A LED (panel indicator)
D/AR	18	D/A Reset
DDCL	12	Direct Digitize Clear
$DECAD_n$	9	Decode Address n
DIG	4	Digitize (Normal or Fast)
DIGBRLED	4	Digitize Burst LED (panel indicator)
DIGBUR	4	Digitize Burst
DIGBURR	18	Digitize Burst Reset
DIGN	4	Digitize Normal
DIGNLED	4	Digitize Normal LED (panel indicator)
DIGNR	18	Digitize Normal Reset
DIN_x	3	Data In_x (Data to Camera D/A)
$DINS_x$	3	Data In $Stored_x$
DIRDIG	10	Direct Digitize
DISPFD	20	Display Frame Drive
DISPLD	20	Display Line Drive
DLVF	2	Drive Live Video, Filtered
DOT_z	9	Data Out_z (ULI to Camera)
DRGB	19	Data Request Gate B (from Computer)
DU	21	Device Unavailable

Mnemonics	Origin-Sheet No.	Meaning
ENDIGBUR	20	Enable Digitize Burst
ENDIGN	19	Enable Digitize Normal
EOC(Burst)	2	End of Conversion, Burst digitizing mode
EOC(Normal)	2	End of Conversion, Normal digitizing mode
EOF	19	End of File (End of Frame)
EOM	19	End of Medium (End of Line)
ERASE I TLM	6	Erase Current Telemetry
ERON	10	Erase Lights On
ERONA	10	Erase Lights on A
EX	12	Expose
EXAM	19	Examine

Mnenomics	Origin-Sheet No.	Meaning
FEND	15	Frame End
FOCUS COIL HI	6	Focus Coil Hi
FOCUS COIL LO	6	Focus Coil Lo
FOCUS I TLM	6	Focus Current Telemetry
FOCUS PASS V TLM	6	Focus Pass Transistor Voltage Telemetry
FPE	14	Frame Preset
FRESET	15	Frame Reset
FRHI	5	Frame Hi
FR I TLM	5	Frame Current Telemetry
FRLO	5	Frame Lo
FRMANCT	5	Frame Manual Centering
FRR	18	Frame Reset, Playback
FRS	18	Frame Set, Playback
FD	14	Frame Drive
FRSAW	5	Frame Saw
FR SAW MONITOR	5	Frame Saw Monitor
FR YOKE HI	5	Frame Yoke Hi
FR YOKE LO	5	Frame Yoke Lo
FS	14	Frame Sync
FSN	10	Fast Scan
FSNR	1	Fast Scan R
FST	10	Frame Start
FSTCL	12	Frame Start Clear
FT	17	Full Time
FUNCOMM	8	Function Command

Mnemonics	Origin-Sheet No.	Meaning
GAINCL	12	Gain Clear
G1 BIAS	6	G1 Bias
G2 BIAS	6	G2 Bias
GCL	19	Gated Clock
GCLBUR	22	Gated Clock, Burst
GDØ	11	Gain Bit Ø
GD1	11	Gain Bit 1
G1 ELECTRODE	7	Electrode
G2 ELECTRODE	7	G2 Electrode
G3 ELECTRODE	7	G3 Electrode
G4 ELECTRODE	7	G4 Electrode
G2 I TLM	6	G2 Current Telemetry
GLLD	3	Gated Live Line Drive
G1 TLM	7	G1 Telemetry
G2 TLM	7	G2 Telemetry
G3 TLM	7	G3 Telemetry
G4 TLM	7	G4 Telemetry

Mnemonics	Origin-Sheet No.	Meaning
HEATER I TLM	6	Heater Current Telemetry
HON	10	Heater On
HQ	11	Heater Qualified
HTR HI	6	Heater Hi
HTR LO	6	Heater Lo
INITCMP	8	Initialize from Computer
INITIAL	23	Initialize
INTEG	14	Integrate, Frame Sweep
I OFF	23	LED Current Off
I_{TGT} TLM	7	Target Current Telemetry

Mnemonics	Origin-Sheet No.	Meaning
LATCHCL	3	Latch Clear
LCV	1	Live Composite
LD	14	Line Drive
L/DISFD	16	Live or Display Frame Drive
L/DISLD	16	Live or Display Line Drive
L/DISMB	16	Live or Display Mixed Blanking
LED HI	6	LED Hi, Erase
LED LO	6	LED Lo, Erase
LFD	15	Live Frame Drive
LHI	5	Line Sawtooth Hi
+LIMIT	2	Positive Limit
-LIMIT	2	Negative Limit
LINE I TLM	5	Line Current Telemetry
LINE SAW MONITOR	5	Line Sawtooth Monitor
LINE YOKE HI	5	Line Yoke Hi
LINE YOKE LO	5	Line Yoke Lo
LITEON	11	Light On
LIVE	4	Live
LITEONC	10	Light on C
LLD	15	Live Line Drive
LLO	5	Line Sawtooth Lo
LMANCT	5	Line Manual Centering
LMB	15	Live Mixed Blanking
LOAD	17	Load
LS	14	Line Sync
LSAW	5	Line Sawtooth
LVDA	3	Live Video from D/A
LVF	2	Negative Limit

Mnemonics	Origin-Sheet No.	Meaning
MA	18	Mode Bit A
MAD 1	9	Manual Address Bit 1
MAD 2	9	Manual Address Bit 2
MAD 4	9	Manual Address Bit 4
MAD 8	9	Manual Address Bit 8
MAD 16	9	Manual Address Bit 16
MAS	4	Mode Bit A Selected
MB	18	Mode Bit B
MBS	4	Mode Bit B
MCB	15	Mixed Cathode Blanking
MESH BIAS	6	Mesh Bias
MESHCL	12	Mesh Clear
MESHHI	10	Mesh Hi
MESHLES	6	Mesh Less Than Wall
MESHLO	10	Mesh Low
MESH SUPPLY TLM	6	Mesh Supply Telemetry
MESHZO	10	Mesh Zero
MESLLITE	6	Mesh Low Light (front panel indicator)
MINIT	8	Master Initializer
MLOAD	8	Manual Load
MSEL	17	Multiple Line Selection
MUXAD1	9	Multiplexed Address Bit 1
MUXAD2	9	Multiplexed Address Bit 2
MUXAD4	9	Multiplexed Address Bit 4
MUXAD8	9	Multiplexed Address Bit 8

Ms continued on next page

Mnemonics	Origin-Sheet No.	Meaning
MUXV1	9	Multiplexed Value Bit 1
MUXV2	9.	Multiplexed Value Bit 2
MUXV4	9	Multiplixed Value Bit 4
MVØ1	9.	Manual Value Bit 1
MVØ2	9	Manual Value Bit 2
MVØ4	9	Manual Value Bit 4

Mnemonics	Origin-Sheet No.	Meaning
NB FLOAT SUPPLY	1	Narrow Bandwidth Preamp Float Supply
NU	4	Not Used (Clock Disable)
NULED 4		Not Used LED (Clock Disable LED)
PASS	19	Pass
PB	1	Pulse Beam
PBCK	14	Pulse Beam Clock
PBEAM	11	Pulse Beam
PBVID	1	Pulse Beam Video
PC	7	Photocathode
PCAC	6	Photocathode AC
PCCV	6	Photocathode Control Voltage
PCON	10	Photocathode ON
PCTLM	7	Photocathode Telemetry
PREINTEG	23	Pre-Integrate
PROC FRSW	5	Processed Frame Saw
PROC LSAW	5	Processed Line Saw
PROCVID	1	Processed Video
PWRR	11	Power Reset

Mnemonics	Origin-Sheet No.	Meaning
RD	12	Read
RDP	21	Read Processed
RE	15	Reset
READSCV	11	Read Mode, Scan Conversion
RECVID	1	Receiver Video
REF	21	Reference

Mnemonics	Origin-Sheet No.	Meaning
SCLROB	18	Initializing Signal from ULI 1
SCV	11	Scan Conversion
SEC TARGET	1	SEC Sensor Target
SELCHUP	19	Selch Up, Simulated
SELLLD	17	Select Line Line Drive
SELLn	17	Select Line n
SHUTOPN	10	Shutter Open
$SIN\emptyset_y$	8	Status Bit 0_y
SLD	14	Selected Line Drive
SLD/LS	14	Selected Line Drive for Lines per Frame Count
SLDP	21	Selected Line Drive Processed
SMPL	4	Sample
SRG	19	Status Request Gate
SSEL	17	Single Select Line
SSN	10	Scan Size Normal
SSO	10	Scan Size Over
SSZO	11	Scan Size Zero
SSZOC	10	Scan Size Zero C
SSZOFR	5	Scan Size Zero Frame
SSZOL	5	Scan Size Zero Line
START	17	Start
STCV	4	Start Conversion

Mnemonics	Origin-Sheet No.	Meaning
TARGET BIAS	6	Target Bias
TARGET I TLM NB	1	Target Current Telemetry, Narrow Band Preamp
TARGET I TLM WB	1	Target Current Telemetry, Wide Band Preamp
TARGET V TLM NB	1	Target Voltage Telemetry, Narrow Band Preamp
TARGET V TLM WB	1	Target Voltage Telemetry, Wide Band Preamp
TEST	4	Test
TLDP	14	Trailing Edge Line Drive Processed
TMA	4	Test Mode Bit A
TMB	4	Test Mode Bit B
TPIØ	4	Test Point 1Ø
TVP	10	Target Voltage Prepare
TVR	10	Target Voltage Read

Mnemonics	Origin-Sheet No.	Meaning
V_x	9	$Value_x$
VREF	5	Voltage Reference
V_{TGT} TLM	7	Target Voltage Telemetry
WALL BIAS	6	Wall Bias
WB FLOAT SUPPLY	1	Wide Bandwidth Preamp Floating Supply
WBPA	11	Wide Bandwidth Preamp
WRTCLK	11	Write Clock, Scan Conversion
WRT/RED	11	Write/Read
60 HZ	15	60 Hertz Clock

Section 133 System Signal Diagrams

Modification of the existing 70-mm SEC Television Camera into a Parametric Test and Evaluation System required the addition of automated hardware to the existing equipment.[1] To accept this new hardware, changes were required in the existing electronics and new electronics had to be designed and fabricated.

The overall PTS system signal flow diagrams which follow (sheets 1 through 23), can be separated into 8 functional blocks. See Figure 131.

1. Video, Sheets 1 to 4
2. Deflection, Sheet 5
3. Control and Electrode Processing, Sheets 6 and 7
4. Sequence Command, Sheets 8 to 13
5. Sync Generation and Multiplexing, Sheets 14 to 16
6. TV Line Select, Sheet 17
7. Digitizing UlI 1, Sheets 18 to 22
8. Light Box Control, Sheet 23

Of these eight blocks, no changes were required in the Deflection (Sheet 5), Control and Electrode Processing (Sheets 6 and 7) and Sheet 1 of the Video block. In addition, other elements of the existing television camera were incorporated into the PTS, such as:

* Camera Electronics Rack (refer to Figure 31)
    - Conrac T.V. Monitor
    - Tektronix Oscilloscope
    - Camera Power Supplies
    - Chassis 100 and circuit cards (Video, Control)
    - Chassis 200 and circuit cards (Deflection)
    - Main Frame Chassis

[1] Refer to Section 10.

To operate as a Parametric Test and Evaluation System chassis No. 300 was added to the Camera Electronics Rack. Refer to Section 30 and Figures 31 and 35. Included in this chassis from the aforementioned functional blocks are:

*Video: Sheets 2 to 4. Provides for the processing of video into analog to digital conversion for recording onto magnetic tape via magnetic disc. Playback from tape via the disc is also provided (digital to analog conversion). Refer to Section 60.

*Sequence Command: Sheets 8 to 13. Processes the computer commands that control the various camera electrodes, preamp bandwidth selection for the Prepare, Expose and Read cycles. Also initiates the readout of each T.V. line of data when the computer has completed digitizing the previous line. Refer to Section 80.

*Sync Generator: Provides the digital timing signals needed to define the scan line and pixel structure required during Prepare and Read Cycles. Refer to Section 70.

*T.V. Line Select: Allows the system operator to visually display a line or a group of lines during system set up. This particular function is useful only during line camera operation (non-digitizing mode). Refer to Section 70.

*Digitizing ULI 1: Sheets 18 to 22. Decodes the computer information into digitize normal, digitize burst or playback commands (Sheet 18). Sheet 19 performs three tasks: (1) during digitizing the ULI reports to the computer on the validity of the data lines, (2) the computer responds on its acceptance of data, (3) computer checks the status of the camera, i.e., power is up, end of frame, end of line. In the burst mode (Sheet 20) the computer tells the burst digitizer what pixel to start burst digitizing. Sheets 21 and 22 are line drivers and receivers for computer to camera interfacing of the ULI 1 card.

*Light Box Controller: Provides the necessary electronics to minotor and control the intensity of the light source in the Light Source and Image Projector. Refer to Figure 32 and Section 50.

No changes or additions were required in the Head Accessory (see Figure 33) for PTS operation. Sheet 5 of the signal flow diagram, designated Deflection, identifies previously designed and fabricated electronics cards located in the accessory unit as well as chassis 200 of the Camera Electronics Rack. Chassis 200 electronics provides the frame and line sweep deflection generators and processors for driving the Celco camera deflection amplifier located in the Head Accessory (Chassis 400). The Celco amplifier is connected to the deflection yoke, located in the SEC Camera Head, via a coax multi-conductor cable.

No changes or additions were necessary to the SEC Camera Head (Chassis 600) Figure 32. Sheet 7, Electrode Processing, of the signal flow diagrams provides for electrode filtering and telemetry of sensor electrode potentials.

Those additional units necessary for semi-automatic data acquisition and control have previously discussed in:

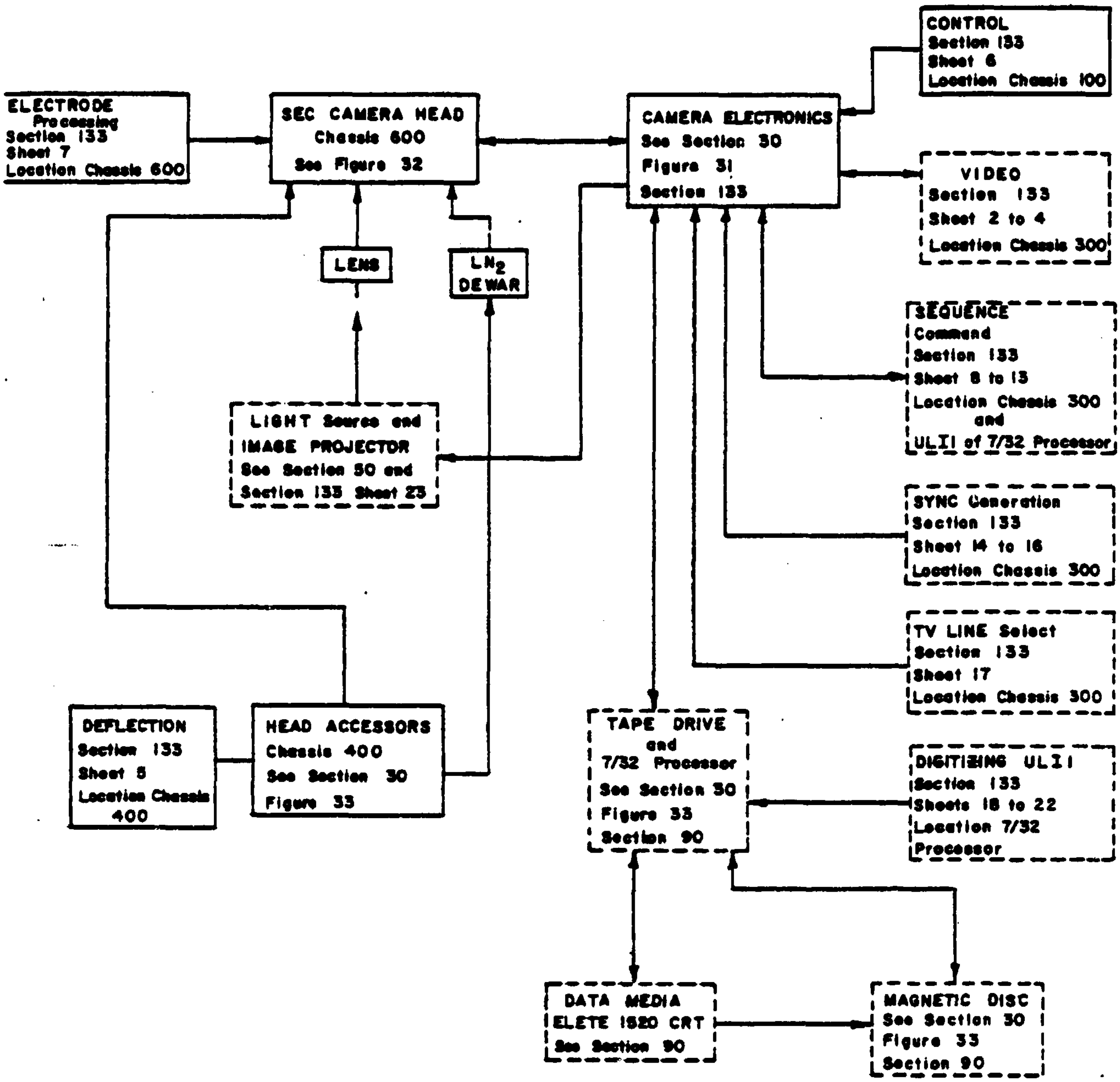
*Section 30: Description of the Parametric Test Set.

*Section 50: Light Source and Test Pattern Projector.

*Section 90: Digital Processing Equipment.

For a detailed schematic of individual cards identified on Sheets 1 to 23, refer to the manufacturing drawing.

Figure 131 is block diagram identifying those elements of the prior existing 70 mm Television Camera and the subsequent addition that make up the PTS.



NOTES

1. The Solid Boxes Represent The Prior Existing 70 mm Television Camera.
2. The Dashed Lines Represent The Additions Needed For PTS Operation.
3. As An Integrated Unit The Solid And Dashed Boxes Are The PTS.

The Operational 70 mm Parametric Test Set System

Figure 131

Location Code Index:

Example (1) Pre-Amp Receiver 100/104/6

Located in chassis	100
Card identification	104
Slot number	6

(2) Burst Mode Selectable Input 300/A-D BUR/6

Located in chassis	300
Card identification	A-D BUR
Slot number	6

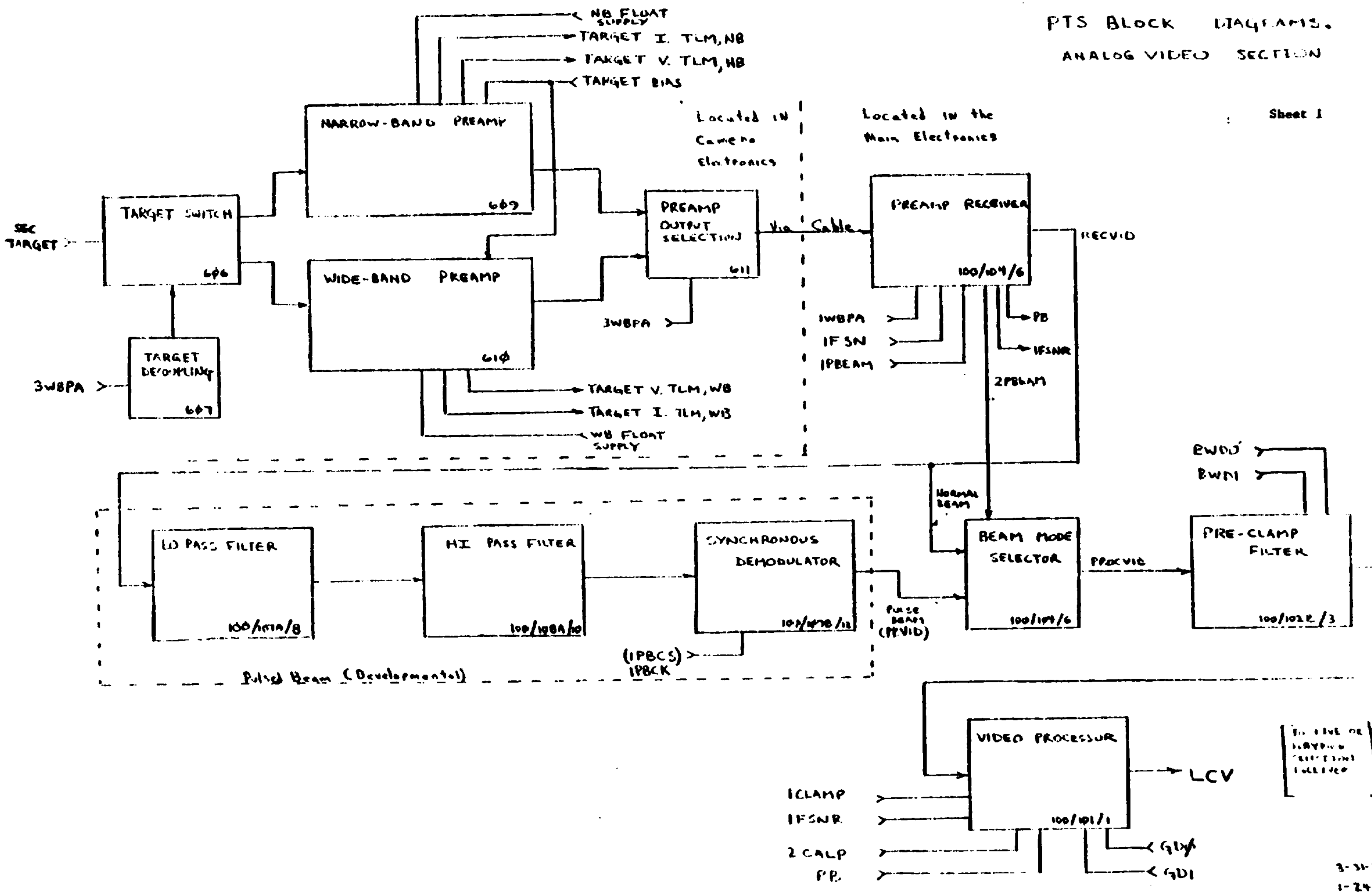
(3) Line Receivers CMP/ULI 1/B5

Located in chassis	Computer
Card identification	ULI 1
Slot number	B-5

PTS BLOCK DIAGRAMS.

ANALOG VIDEO SECTION

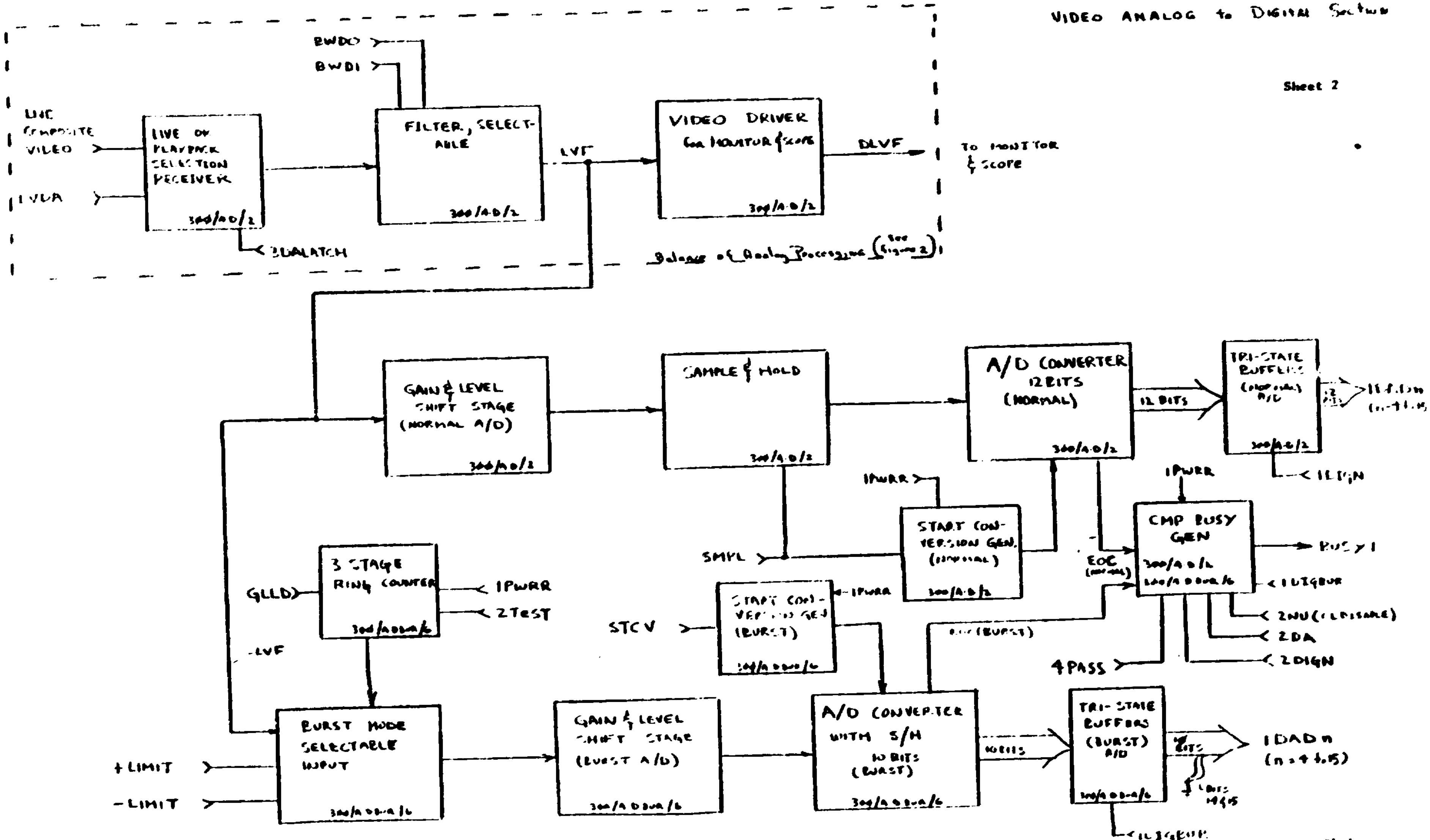
Sheet 1



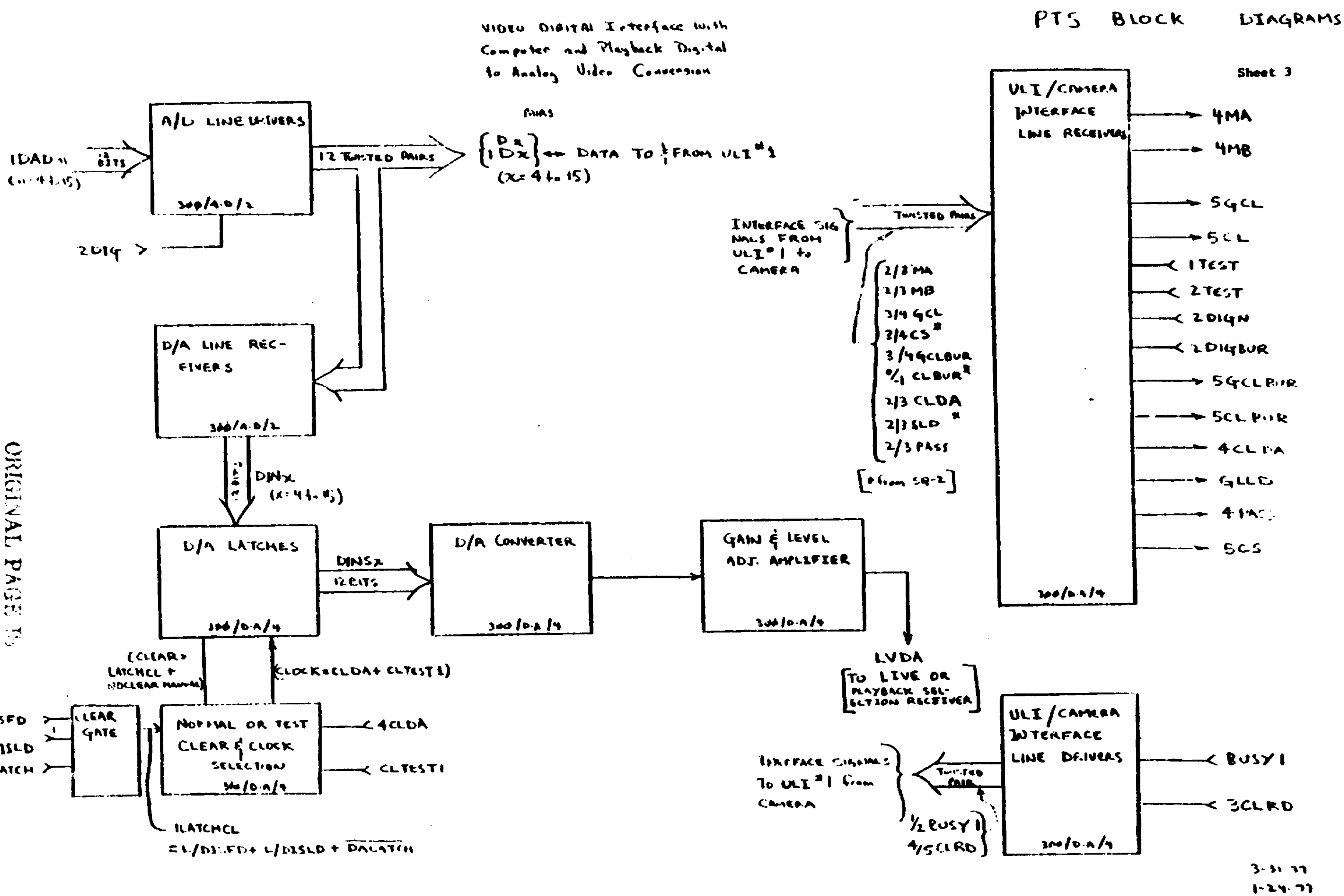
PTS BLOCK DIAGRAMS

VIDEO ANALOG to DIGITAL Section

Sheet 2

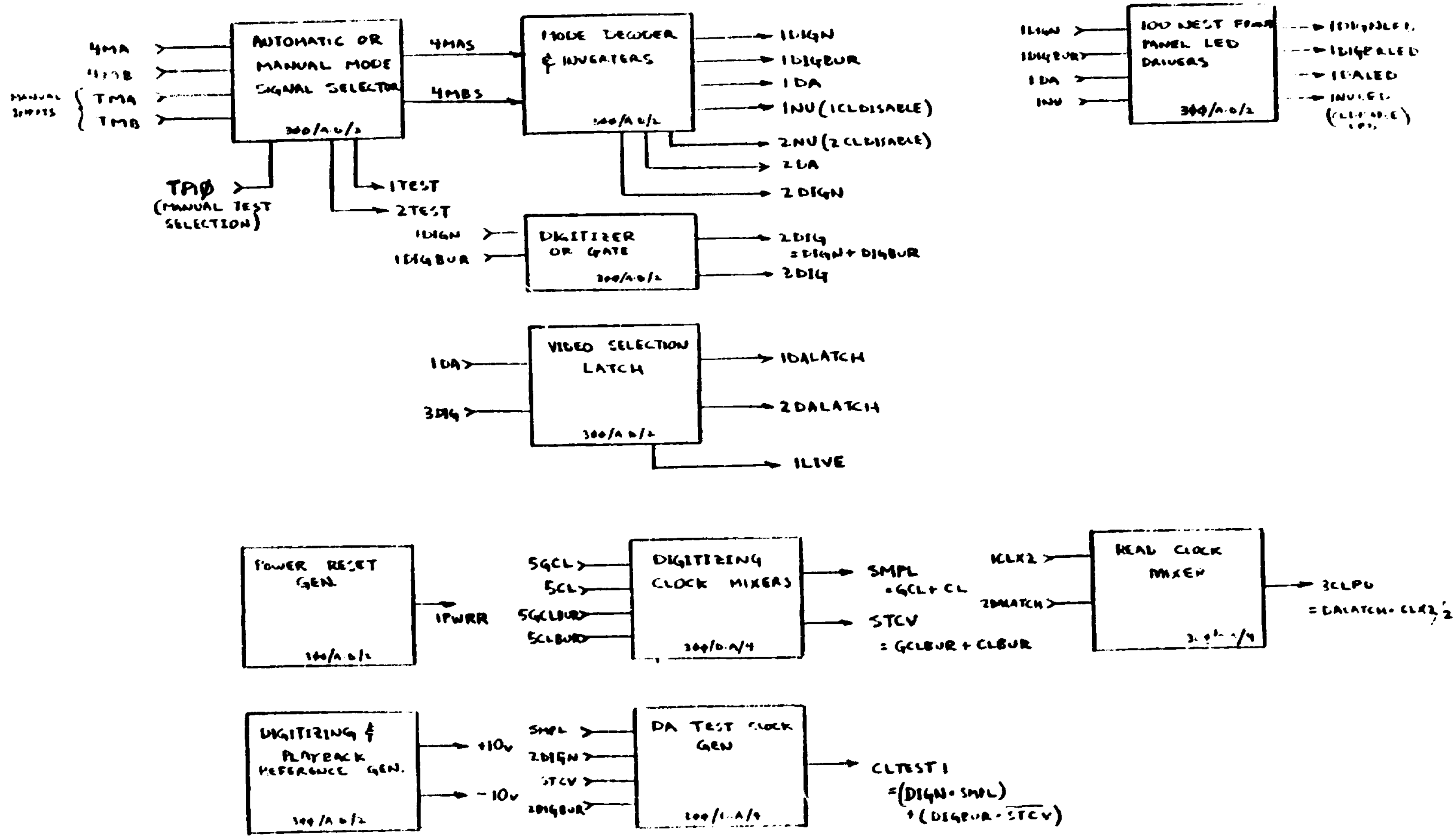


3/31/77
1-24-77


PTS BLOCK DIAGRAMS
Sheet 3
VIDEO DIGITAL Interface with Computer and Playback Digital to Analog Video Conversion
IDADx (x=4 to 15)
12 BITS
A/D LINE DRIVERS
300/A.0/2
2DIG
12 TWISTED PAIRS
PAIRS
Dx
IDx
DATA TO & FROM ULI #1
(x=4 to 15)
D/A LINE RECEIVERS
300/A.0/2
DINx
(x=4 to 15)
D/A LATCHES
300/0.A/4
DINSx
12 BITS
D/A CONVERTER
300/0.A/4
GAIN & LEVEL ADJ. AMPLIFIER
300/0.A/4
LVDA
TO LIVE OR PLAYBACK SELECTION RECEIVER
(CLEAR = LATCHCL + NOCLEAR MANUAL)
(CLOCK = CLDA + CLTEST 1)
1L/DISFD
1L/DISLD
2DALATCH
CLEAR GATE
NORMAL OR TEST CLEAR & CLOCK SELECTION
300/0.A/4
4CLDA
CLTEST1
1LATCHCL
= L/DISFD + L/DISLD + $\overline{DALATCH}$
ULI/CAMERA INTERFACE LINE RECEIVERS
300/0.A/4
4MA
4MB
5GCL
5CL
1TEST
2TEST
2DIGN
2DIGBUR
5GCLBUR
5CLBUR
4CLDA
GLLD
4PASS
5CS
INTERFACE SIGNALS FROM ULI #1 to CAMERA
TWISTED PAIRS
2/3 MA
2/3 MB
3/4 GCL
3/4 CS *
3/4 GCLBUR
0/1 CLBUR *
2/3 CLDA
2/3 SLD *
2/3 PASS
[* from SQ-2]
ULI/CAMERA INTERFACE LINE DRIVERS
300/0.A/4
BUSY1
3CLRD
INTERFACE SIGNALS TO ULI #1 from CAMERA
TWISTED PAIR
1/2 BUSY1
4/5 CLRD
3-31-77
1-24-77

PTS BLOCK DIAGRAMS
VIDEO SECTION

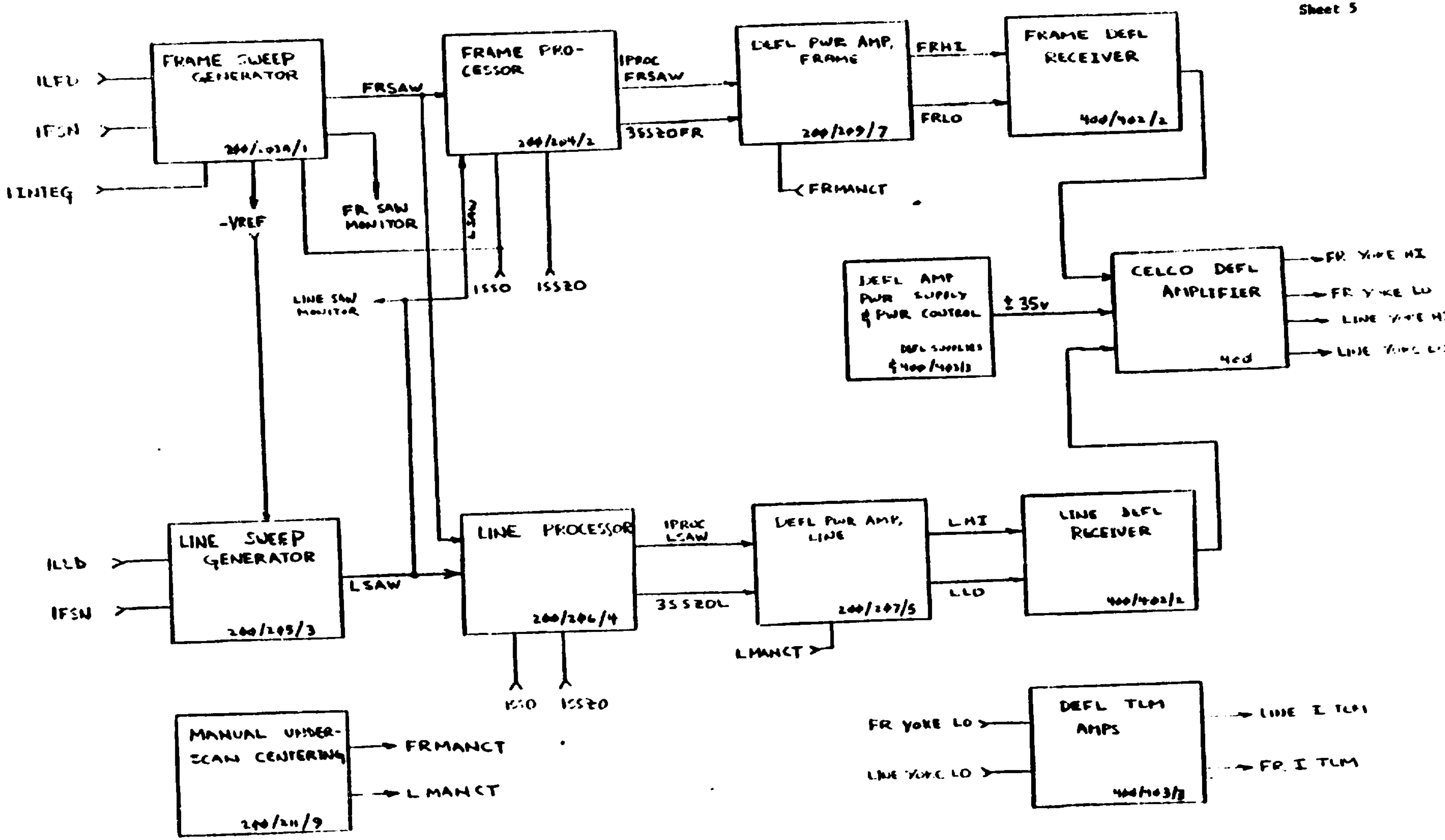
Sheet 4



1-24-77

PTS BLOCK DIAGRAMS
DEFLECTION SECTION

Sheet 5

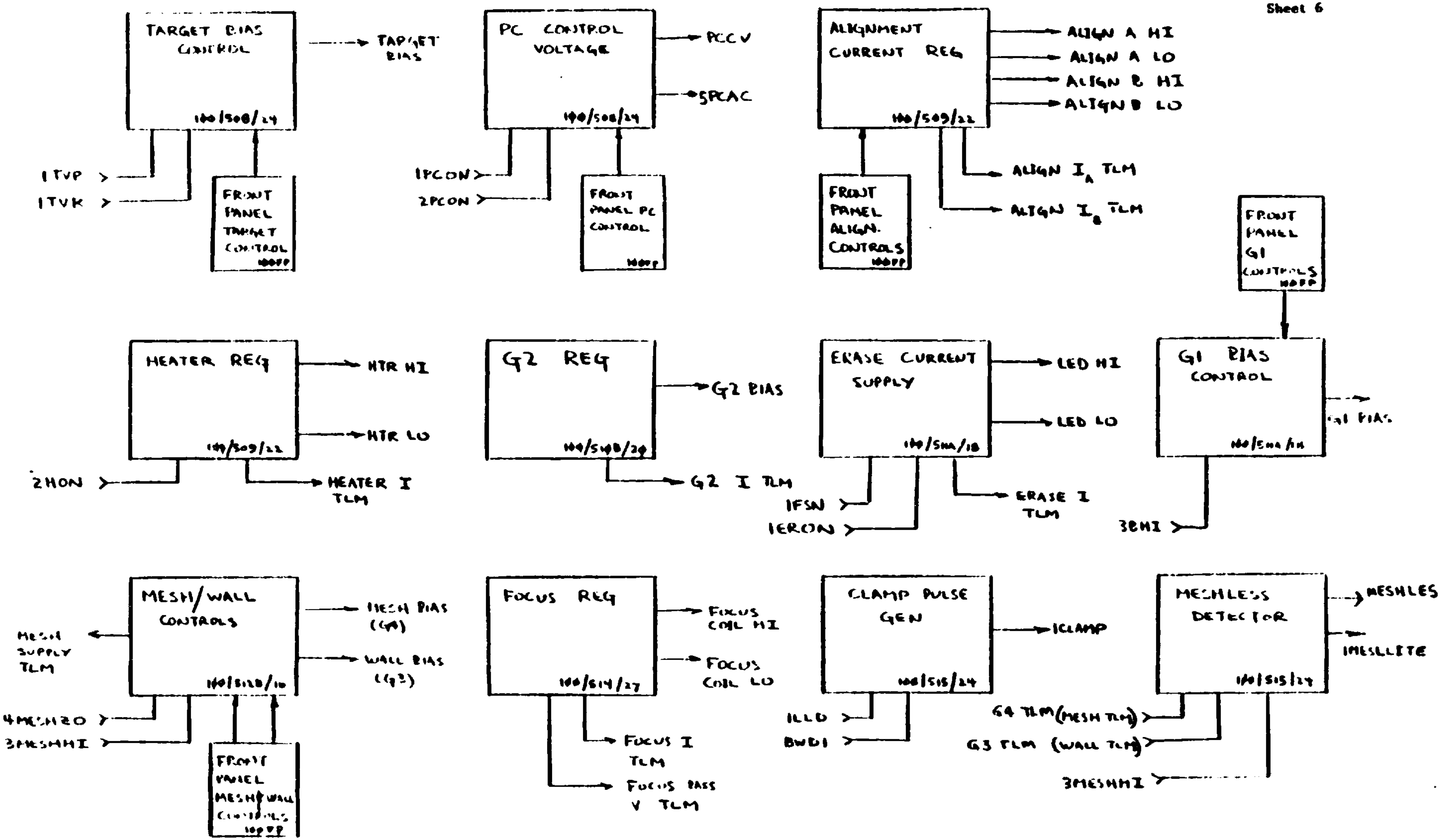


11/5/71

PTS BLOCK DIAGRAMS

CONTROL SECTION

Sheet 6

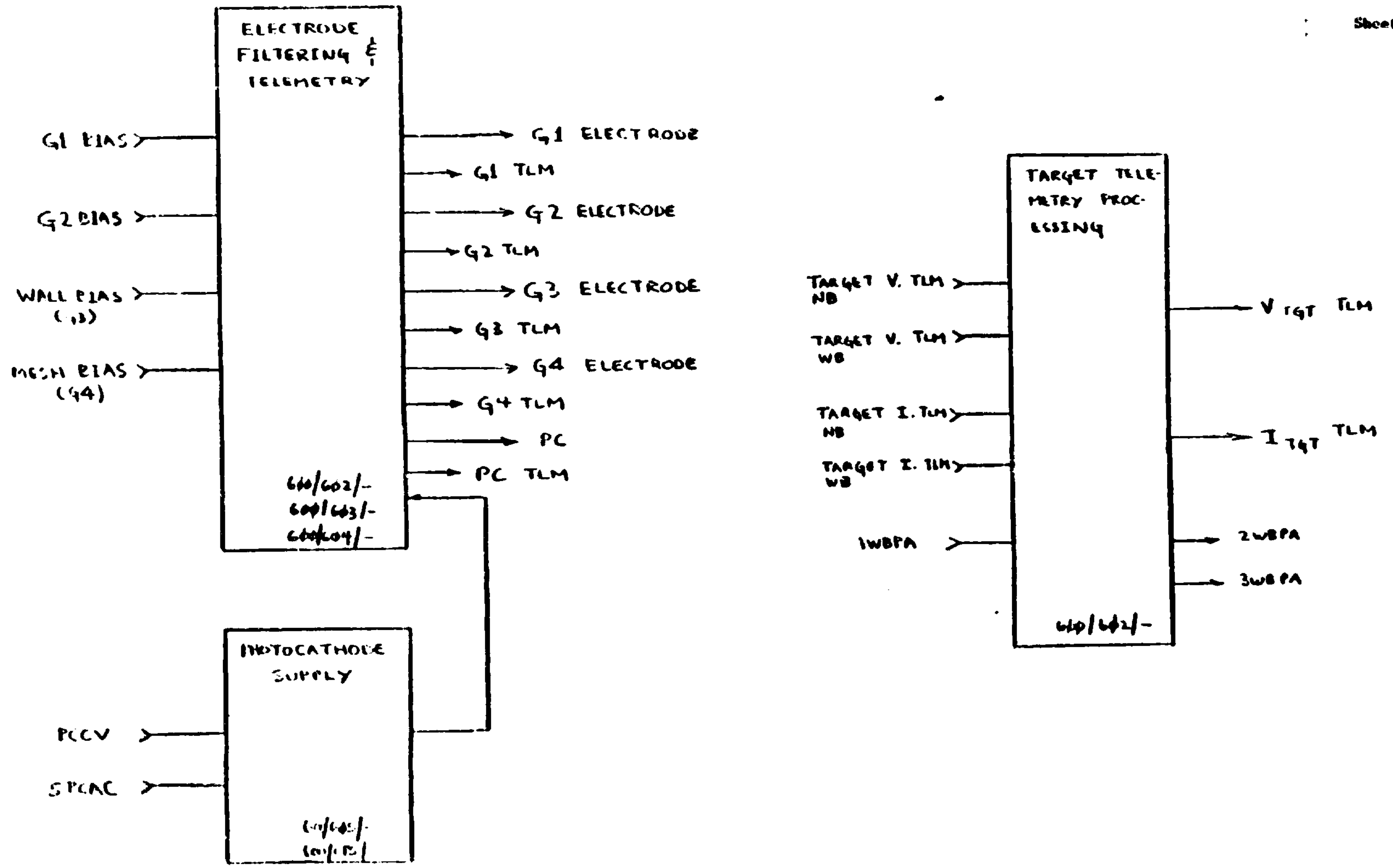


1-25-77

PTS BLOCK DIAGRAM

ELECTRODE PROCESSING

Sheet 7

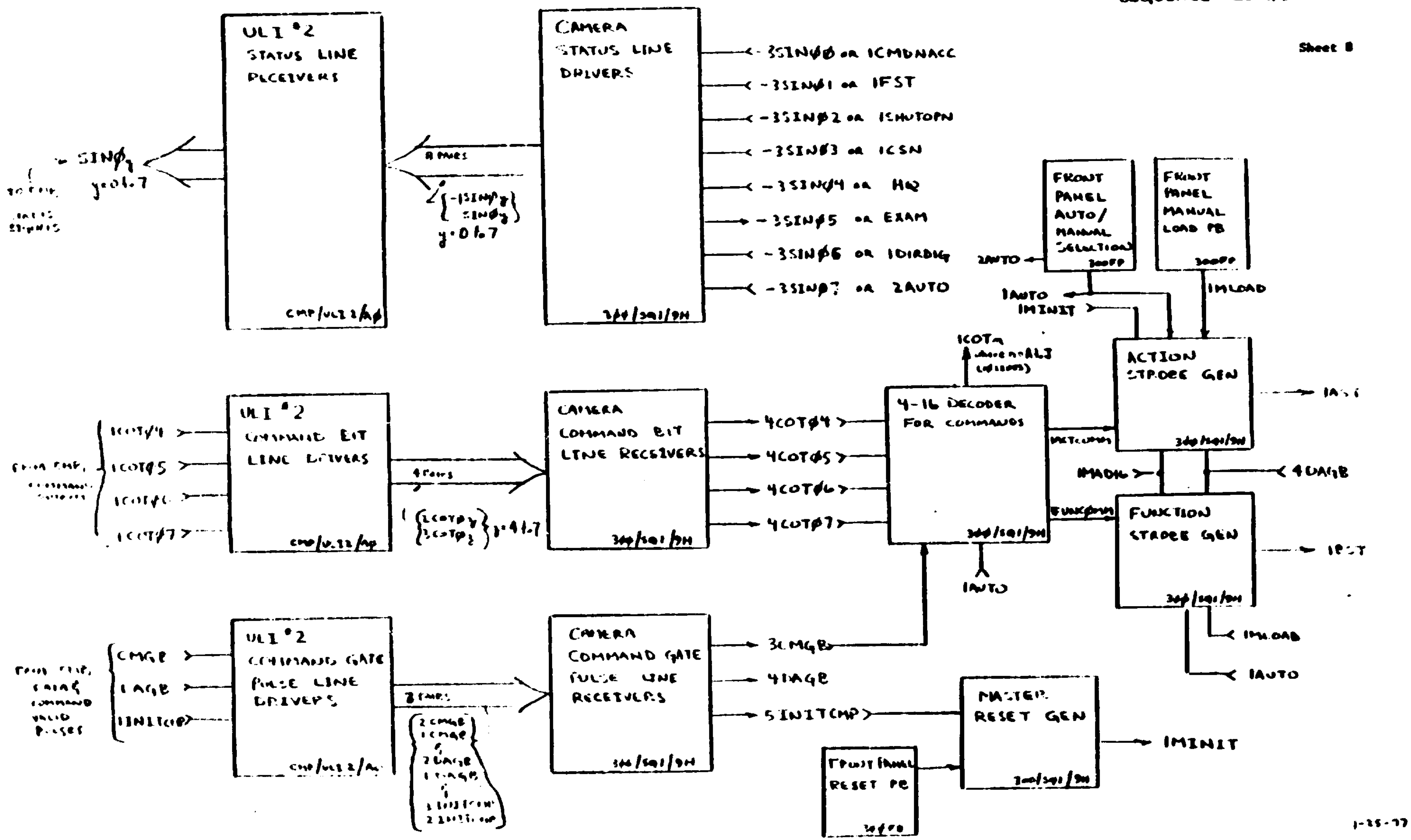


3-18-77

PTS BLOCK DIAGRAMS

SEQUENCE COMMAND SECTION

Sheet 8

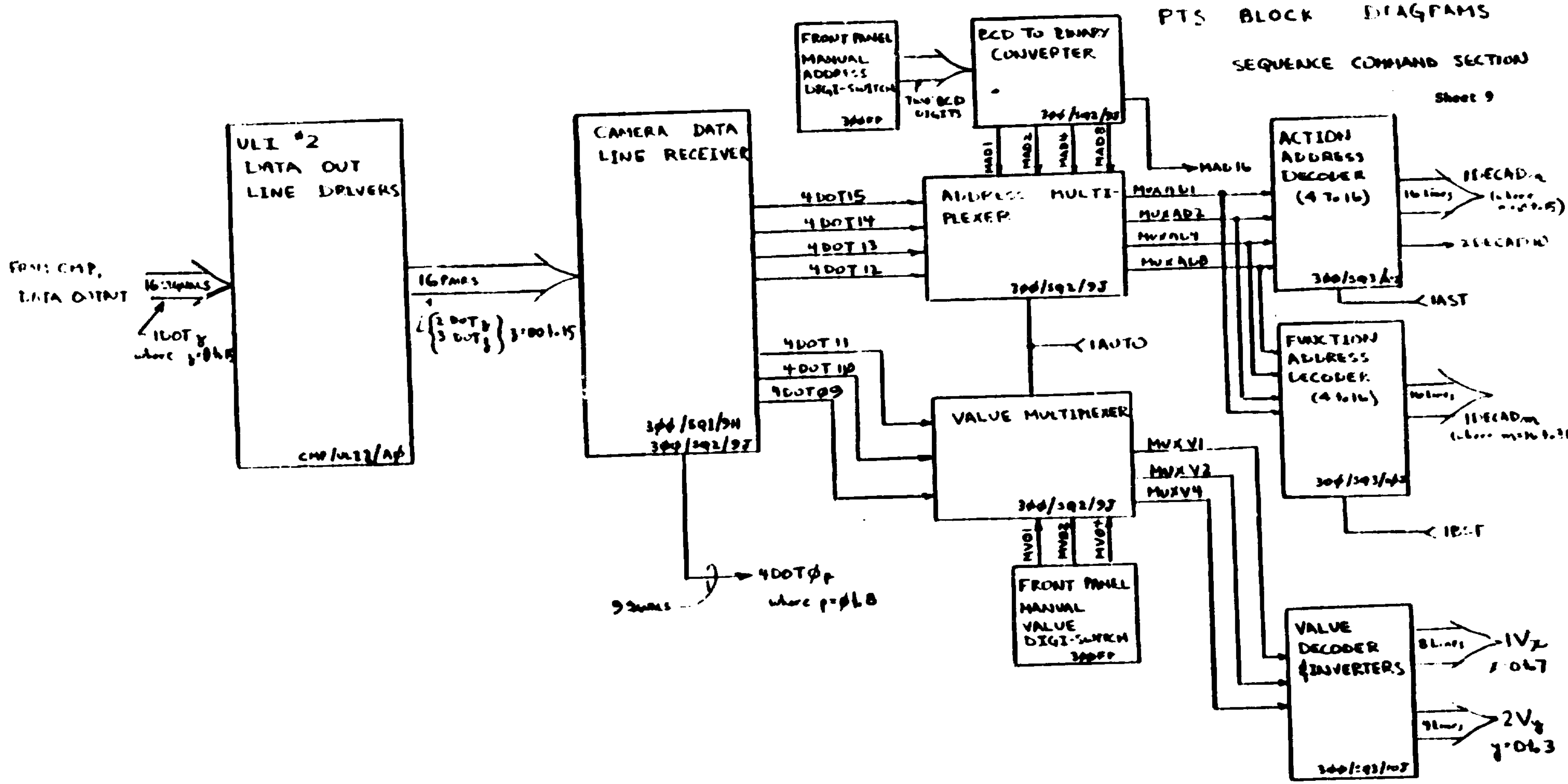


1-25-77

PTS BLOCK DIAGRAMS

SEQUENCE COMMAND SECTION

Sheet 9

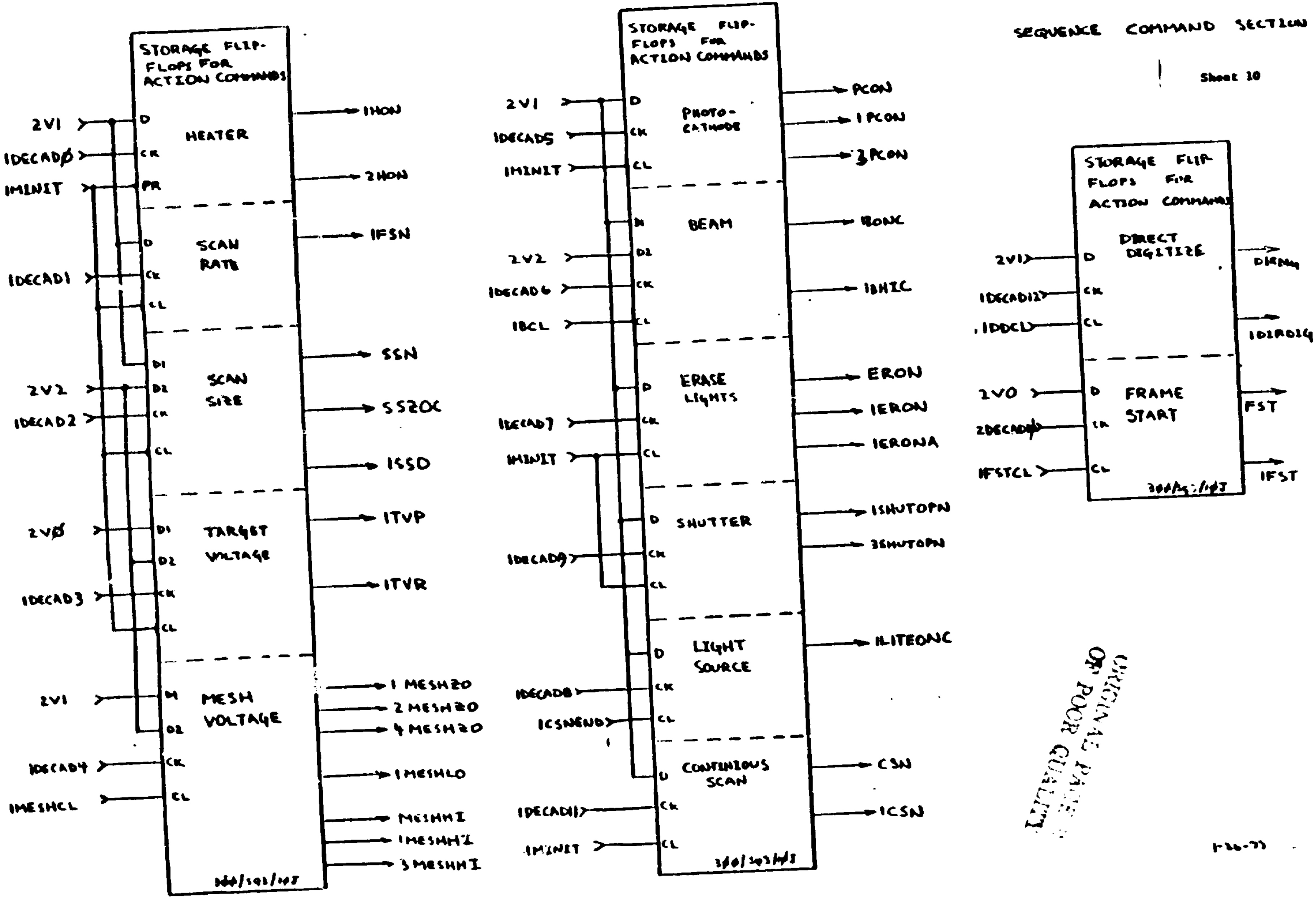


1-15-77

PTS BLOCK DIAGRAM

SEQUENCE COMMAND SECTION

Sheet 10

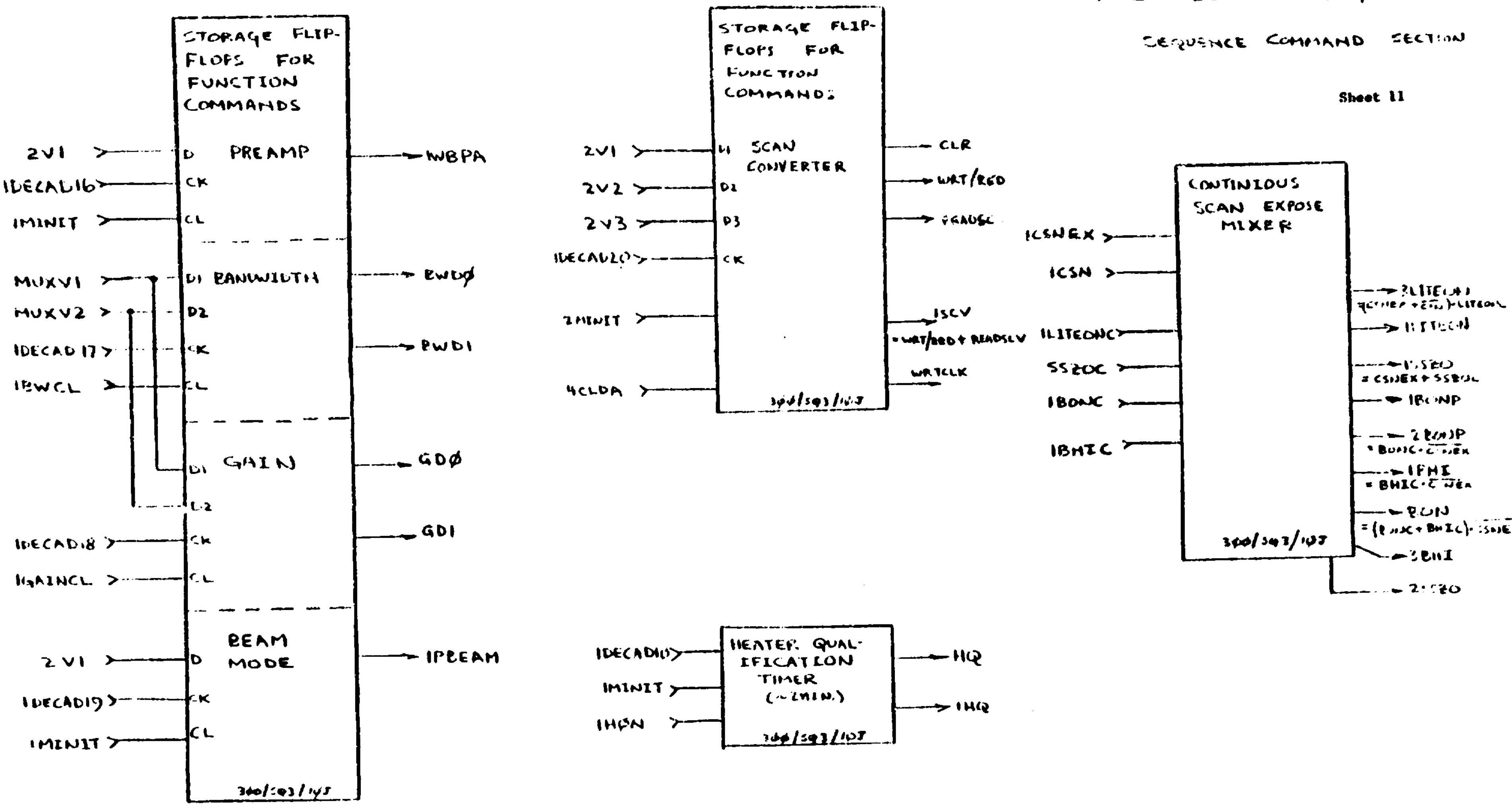


1-26-73

PTS BLOCK DIAGRAM

SEQUENCE COMMAND SECTION

Sheet 11

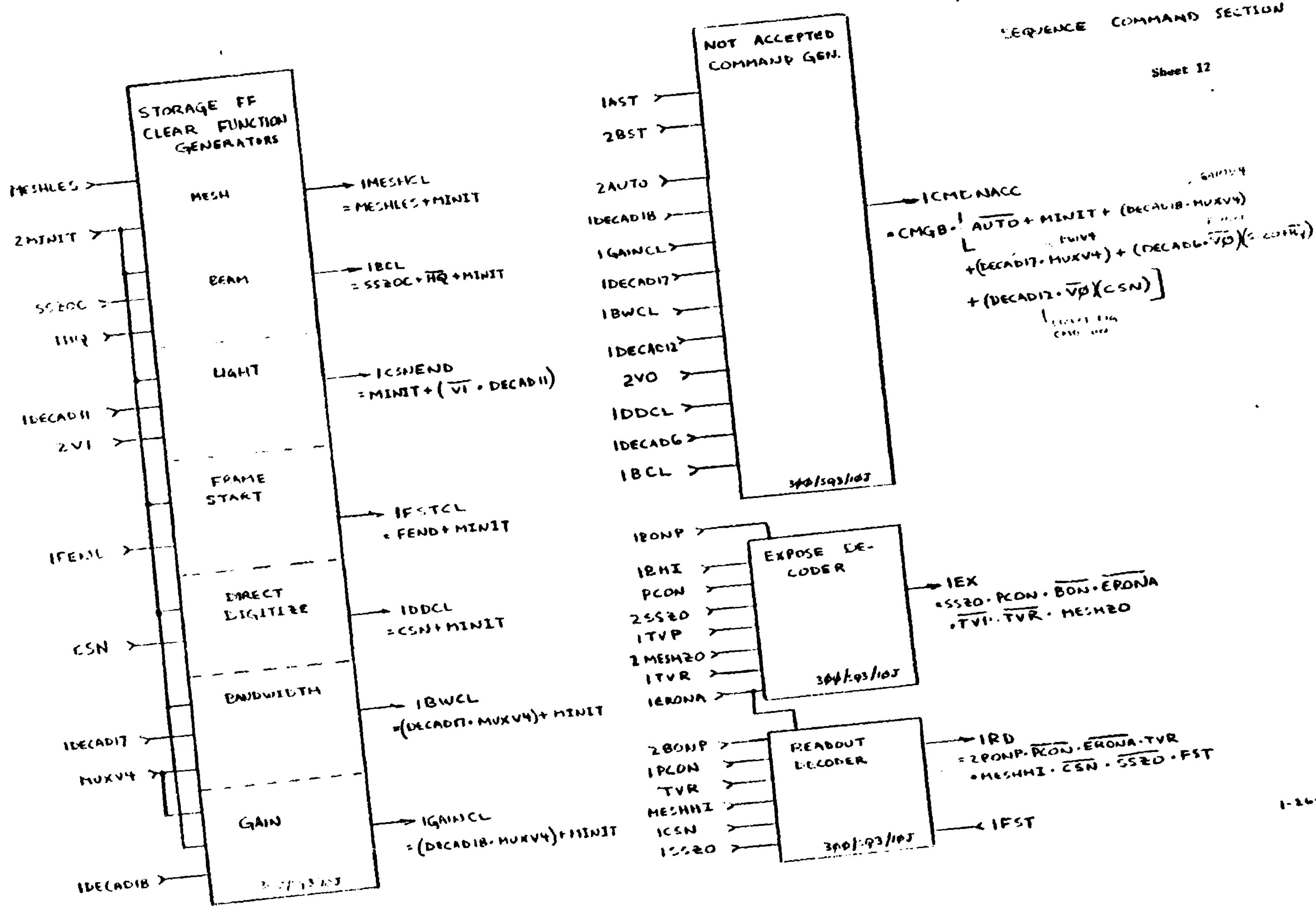


1-26-77

PTS BLOCK DIAGRAM

SEQUENCE COMMAND SECTION

Sheet 12

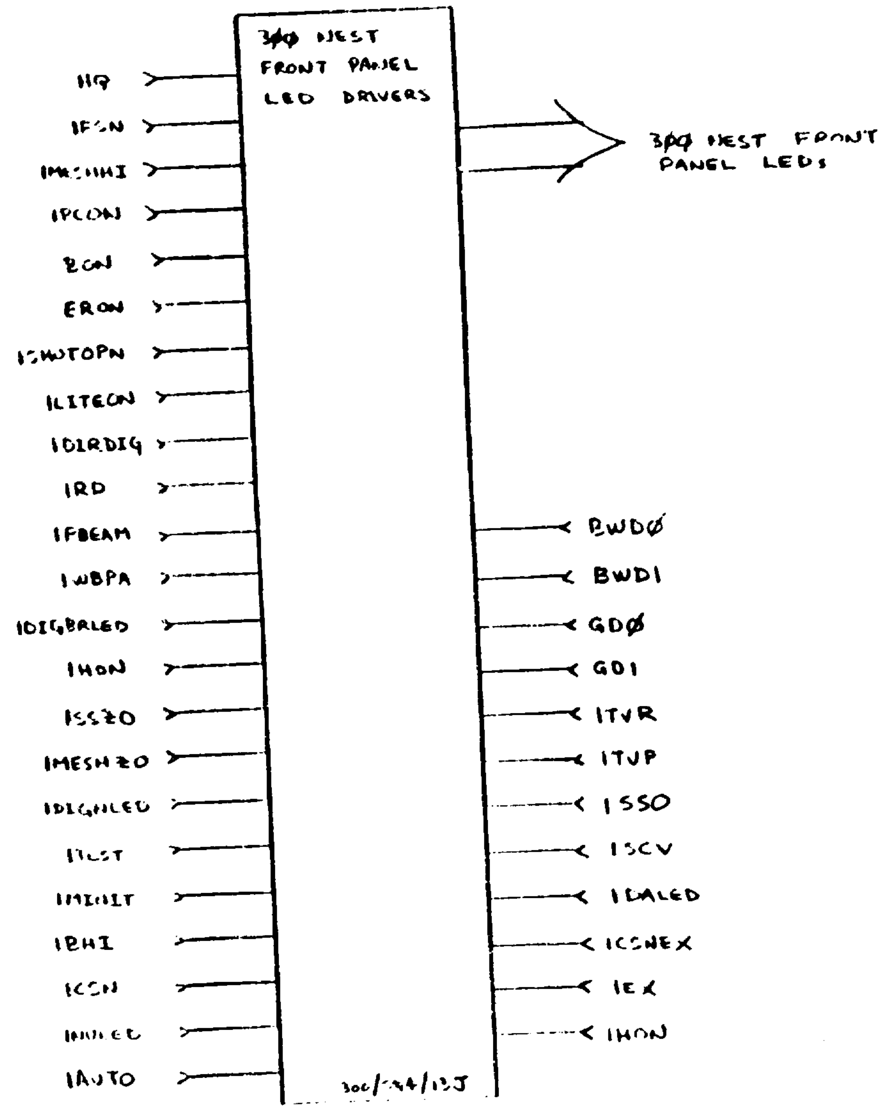


1-26-77

PTS BLOCK DIAGRAM

SEQUENCE COMMAND SECTION

Sheet 13

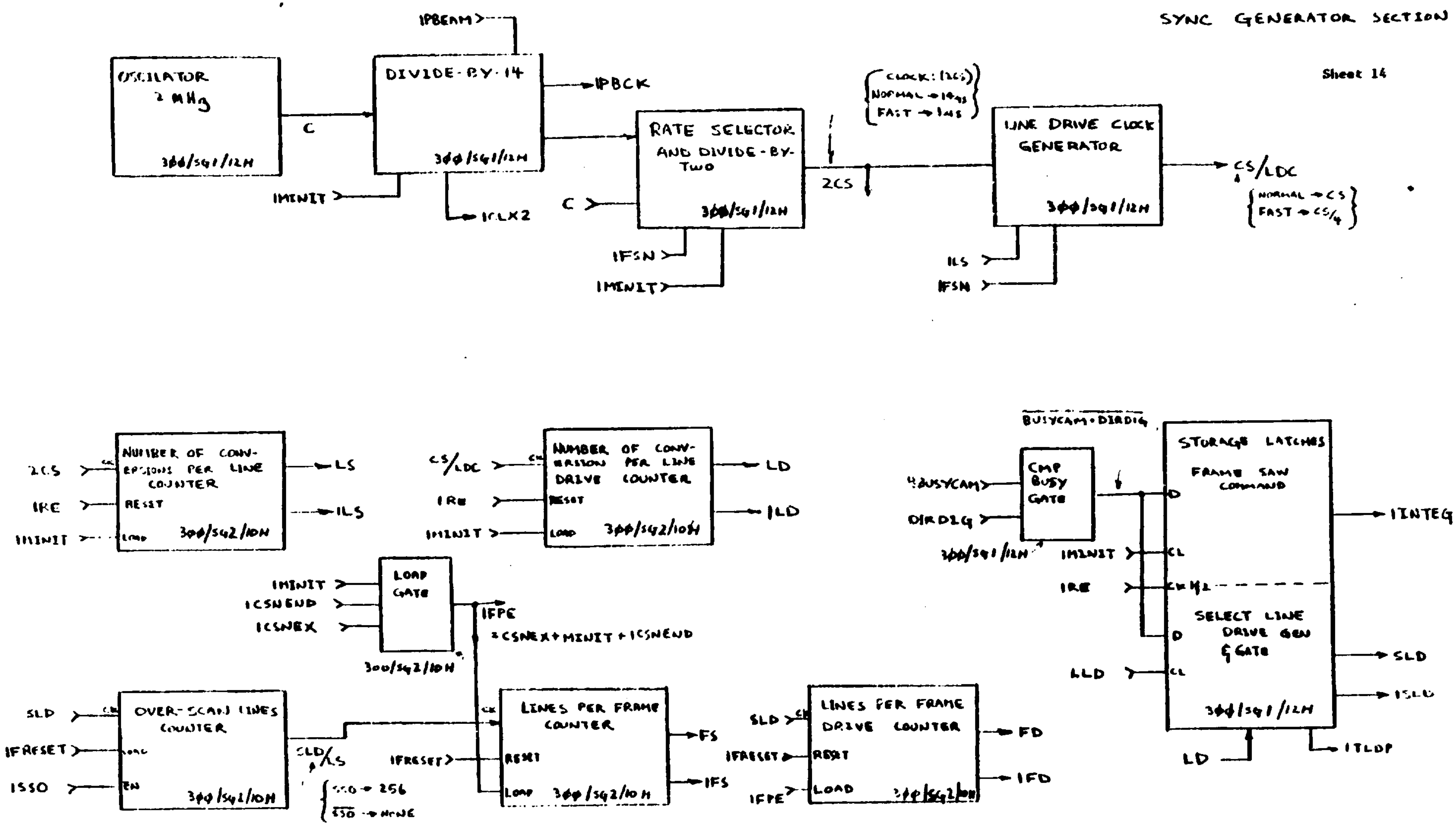


3-17-77

PTS BLOCK DIAGRAM

SYNC GENERATOR SECTION

Sheet 14

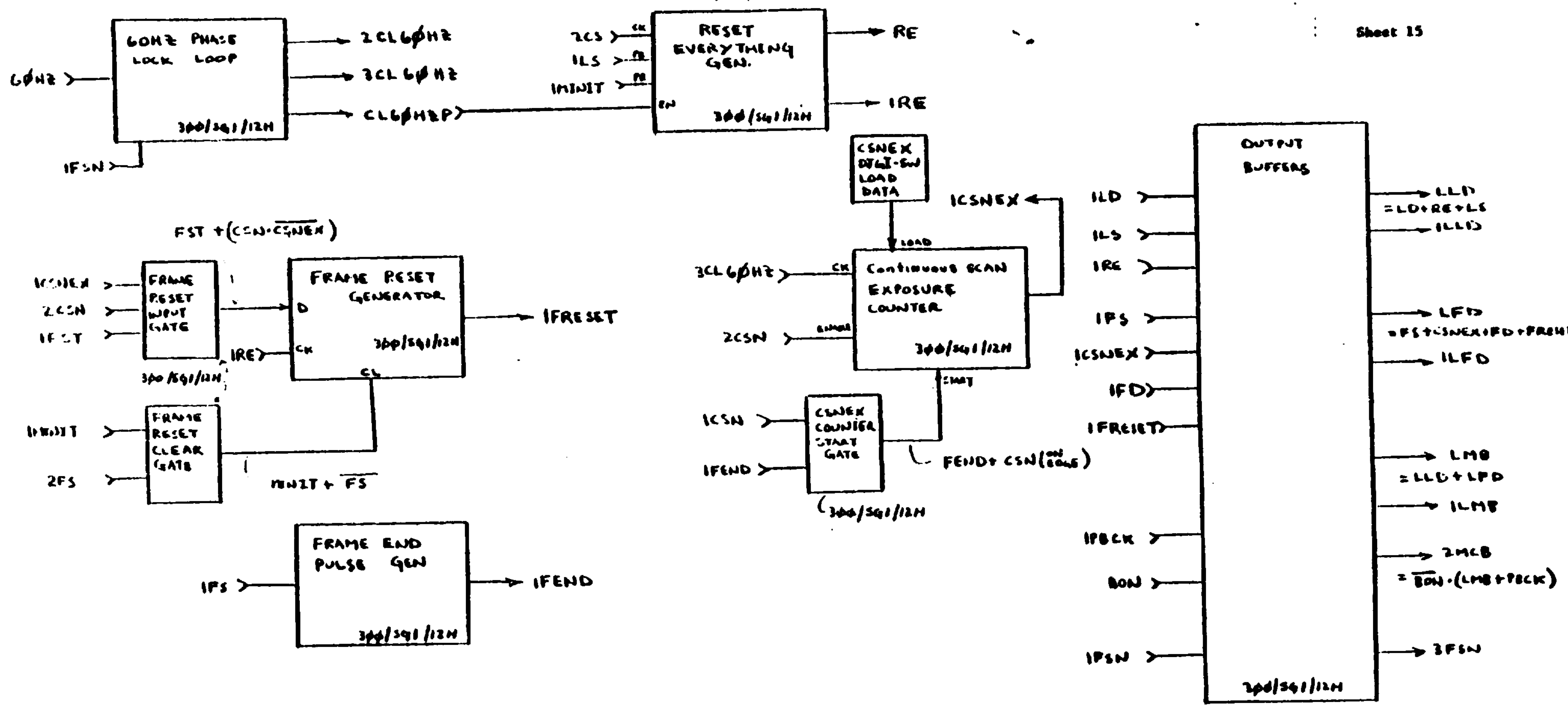


2/1/77

PTS BLOCK DIAGRAM

SYNC GENERATOR SECTION

Sheet 15

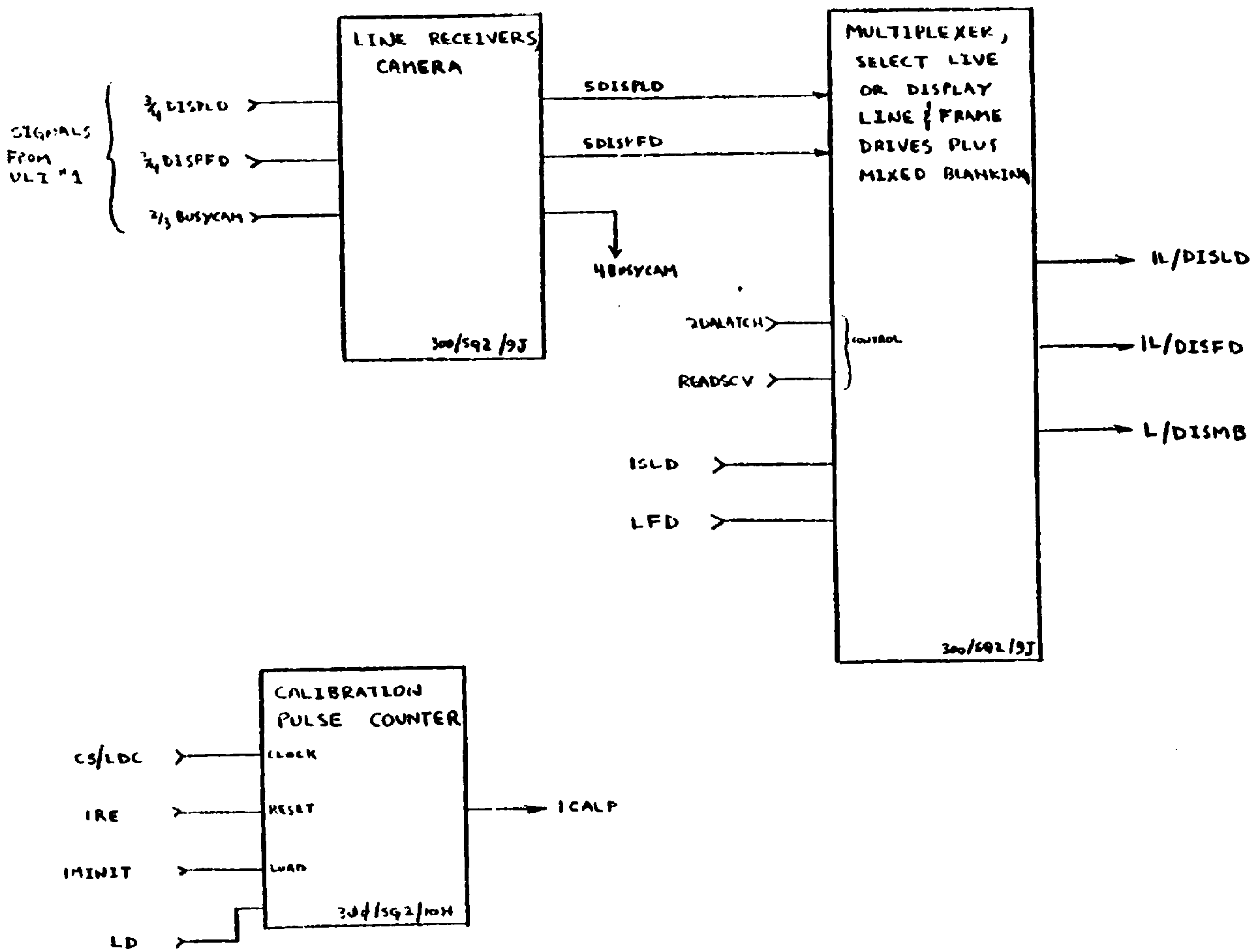


4-1-13

PTS BLOCK DIAGRAM

SYNC Multiplexer SECTION

Sheet 16

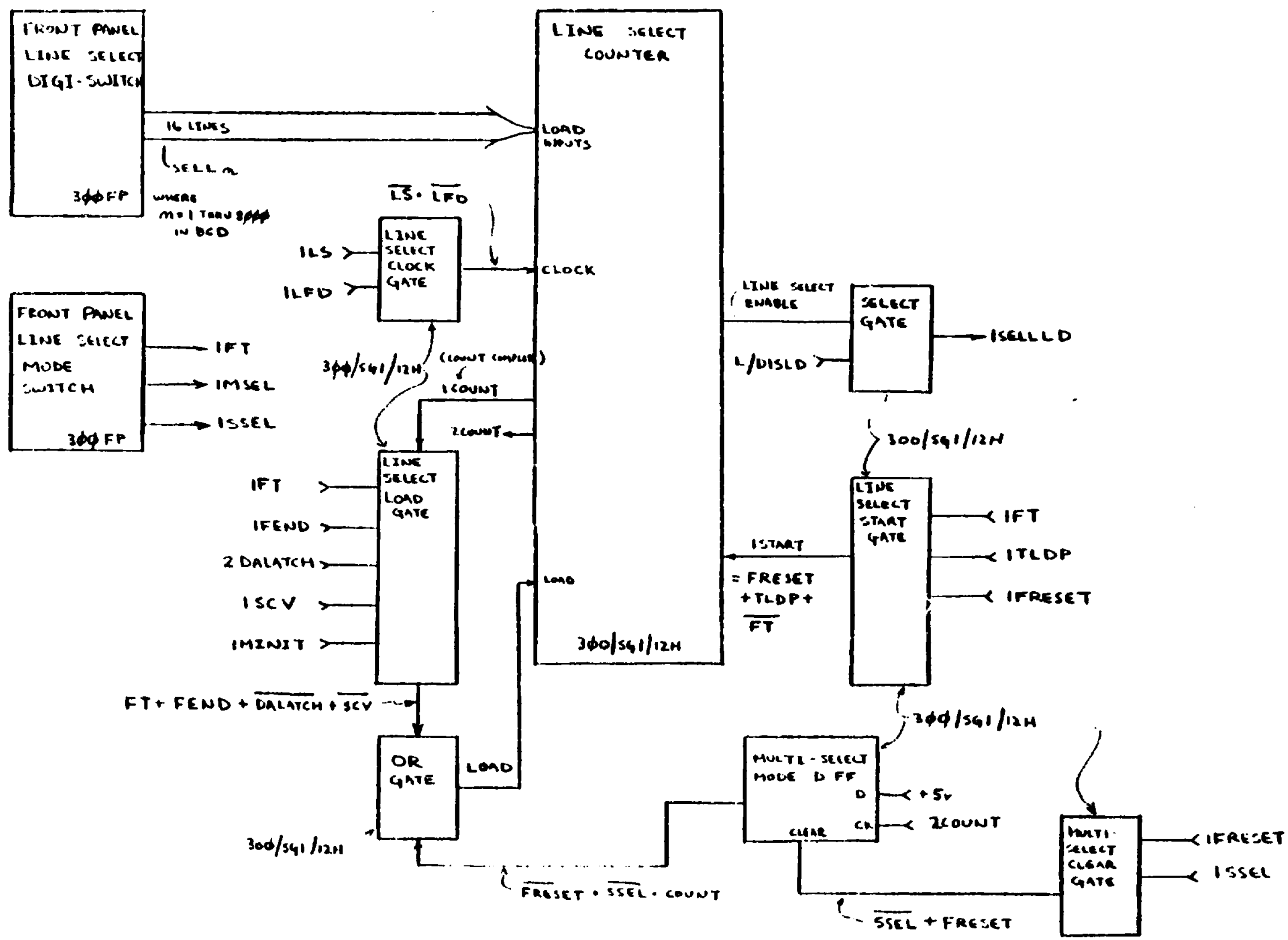


3/1/77

PTS BLOCK DIAGRAM

TV LINE SELECTOR

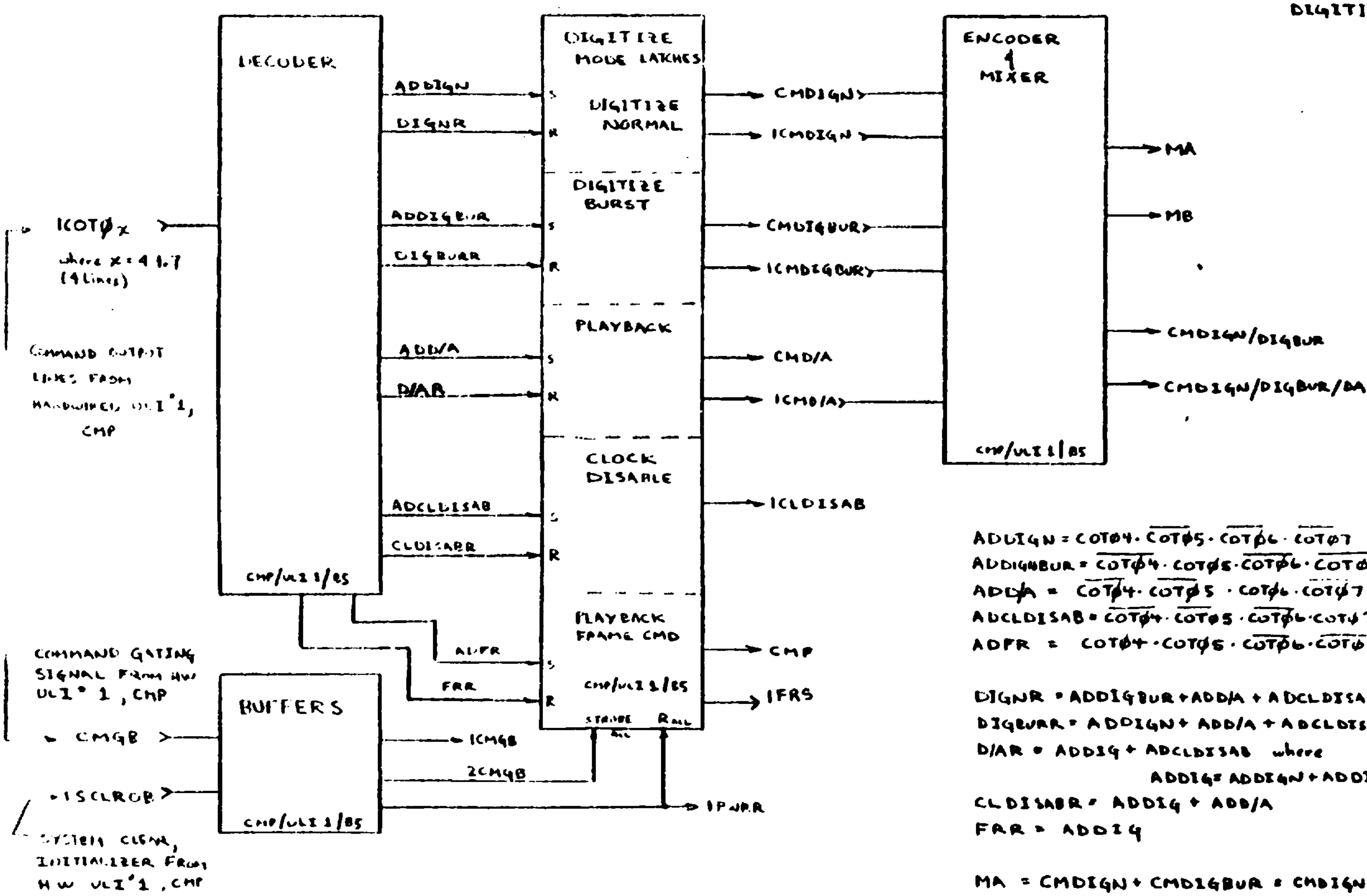
Sheet 17



PTS BLOCK DIAGRAM

DIGITIZING ULI #1

Sheet 18



$ADDIGN = COT\phi 4 \cdot \overline{COT\phi 5} \cdot \overline{COT\phi 6} \cdot \overline{COT\phi 7}$

$ADDIGNBUR = \overline{COT\phi 4} \cdot COT\phi 5 \cdot \overline{COT\phi 6} \cdot \overline{COT\phi 7}$

$ADD/A = \overline{COT\phi 4} \cdot COT\phi 5 \cdot COT\phi 6 \cdot \overline{COT\phi 7}$

$ADCLDISAB = \overline{COT\phi 4} \cdot COT\phi 5 \cdot \overline{COT\phi 6} \cdot COT\phi 7$

$ADFR = COT\phi 4 \cdot COT\phi 5 \cdot \overline{COT\phi 6} \cdot \overline{COT\phi 7}$

DIGNR = ADDIGBUR + ADD/A + ADCLDISAB

DIGBURR = ADDIGN + ADD/A + ADCLDISAB

D/AR = ADDIG + ADCLDISAB where

ADDIG = ADDIGN + ADDIGBUR

CLDISABR = ADDIG + ADD/A

FRR = ADDIG

MA = CMDIGN + CMDIGBUR = CMDIGN/CMDIGBUR

MB = CMDIGN + CMD/A

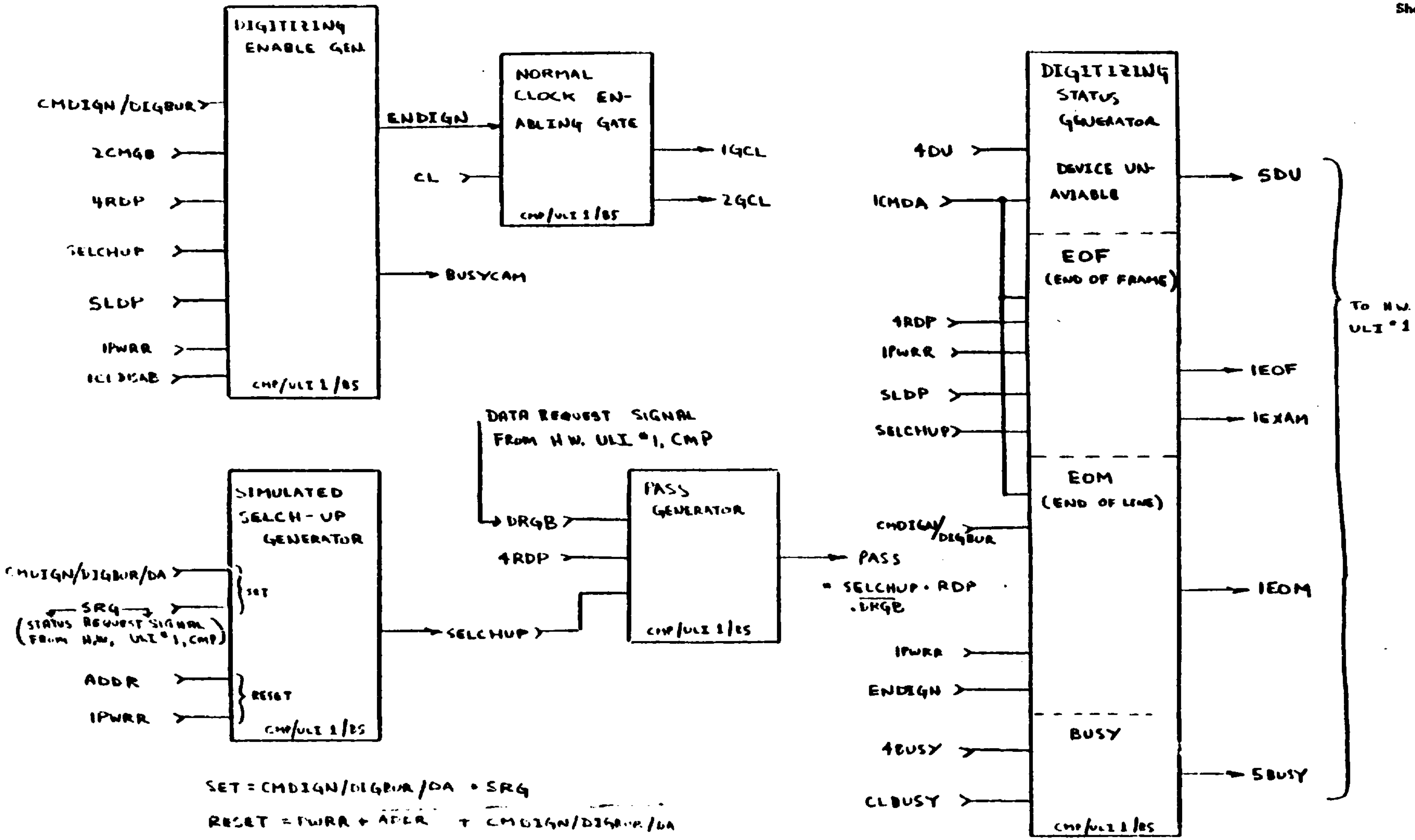
CMDIGN/CMDIGBUR/CMD/A = CMDIGN + CMDIGBUR + CMD/A

3-8-77

PTS BLOCK DIAGRAM

DIGITIZING ULI # 1

Sheet 19



SET = CMDIGN/DIGBUR/DA · SRG

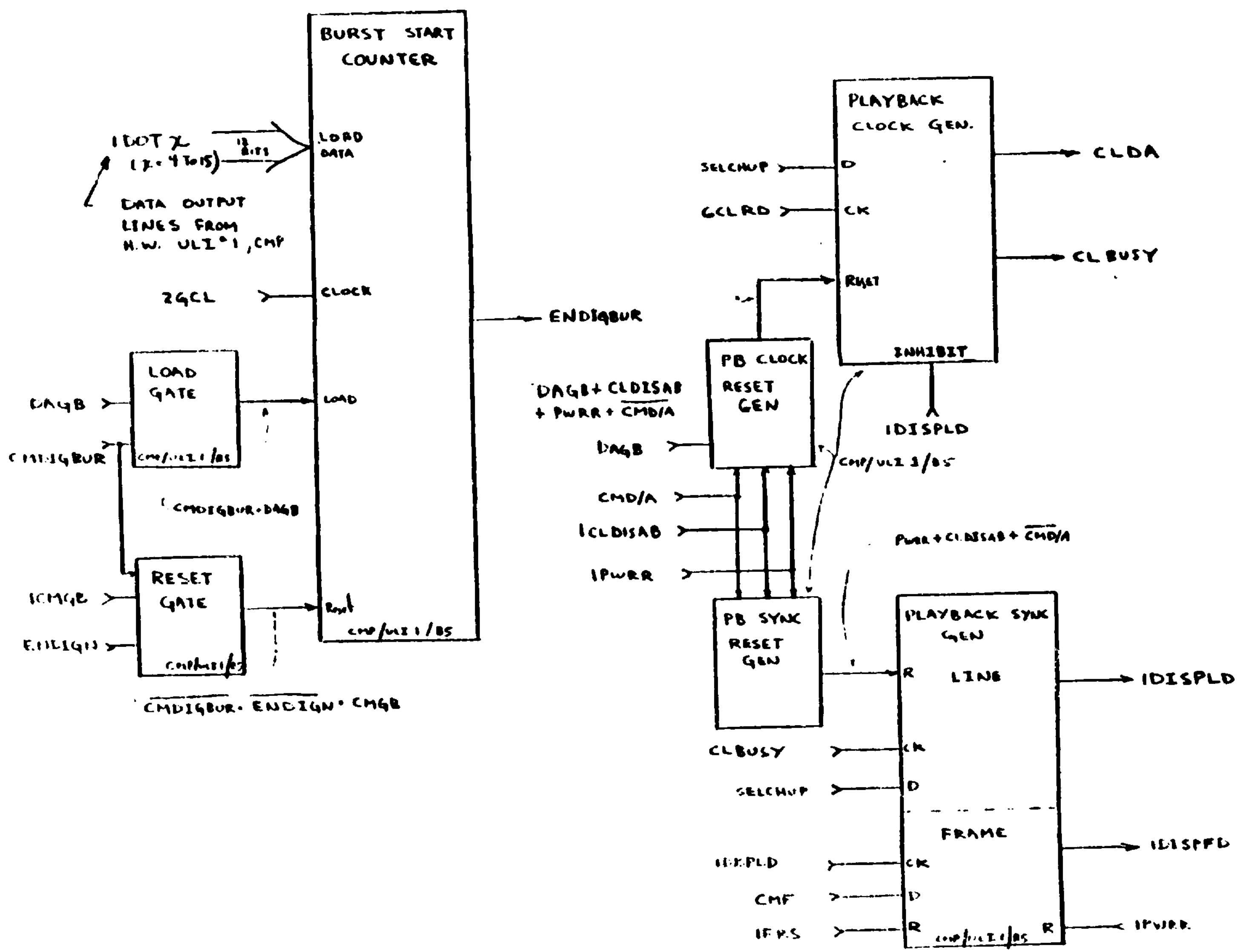
RESET = 1PWRR + ADDR + $\overline{\text{CMDIGN/DIGBUR/DA}}$

3-8-77

PTS BLOCK DIAGRAM

DIGITIZING ULI #1

Sheet 20

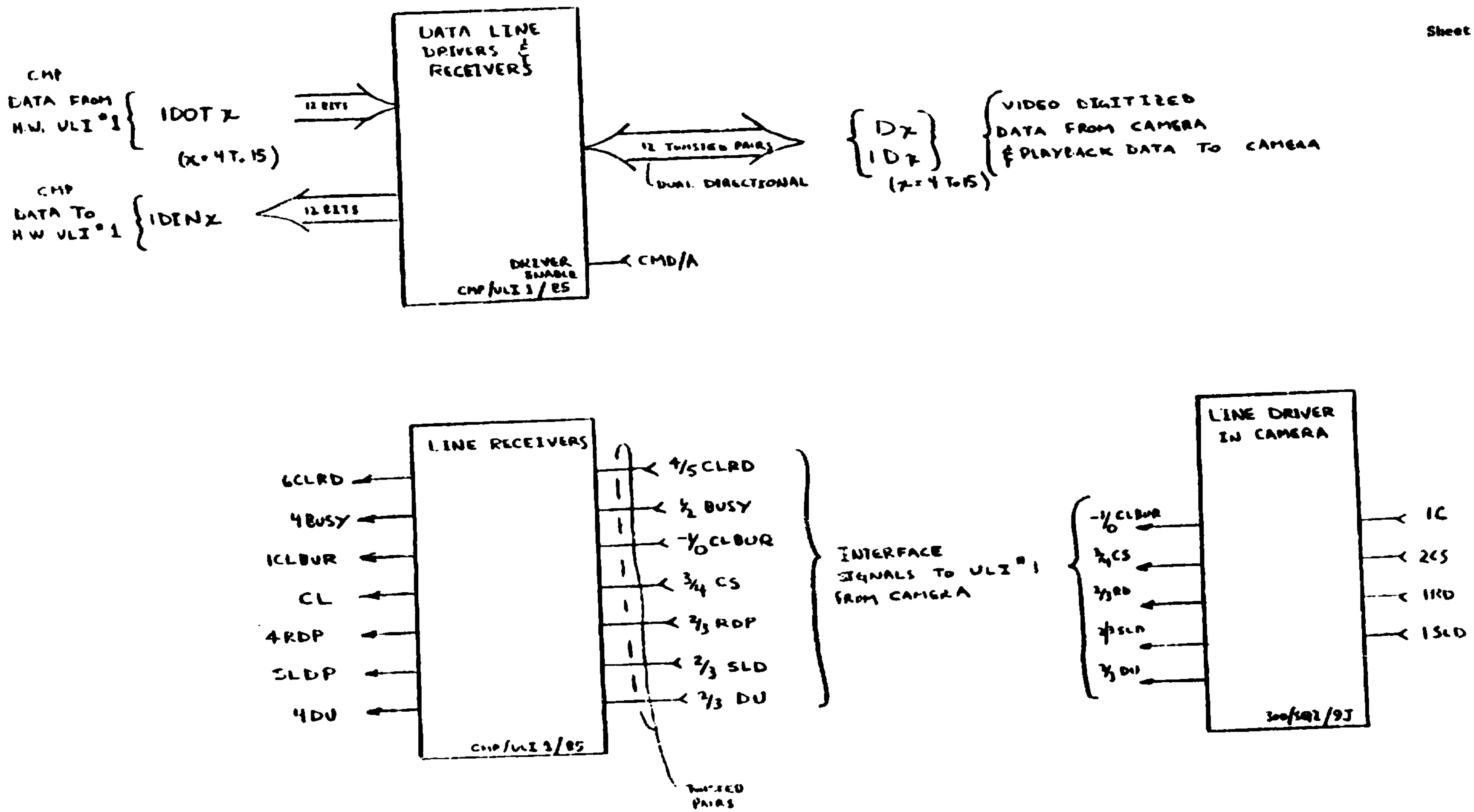


3-8-71

PTS BLOCK DIAGRAM

DIGITIZING ULI #1

Sheet 21

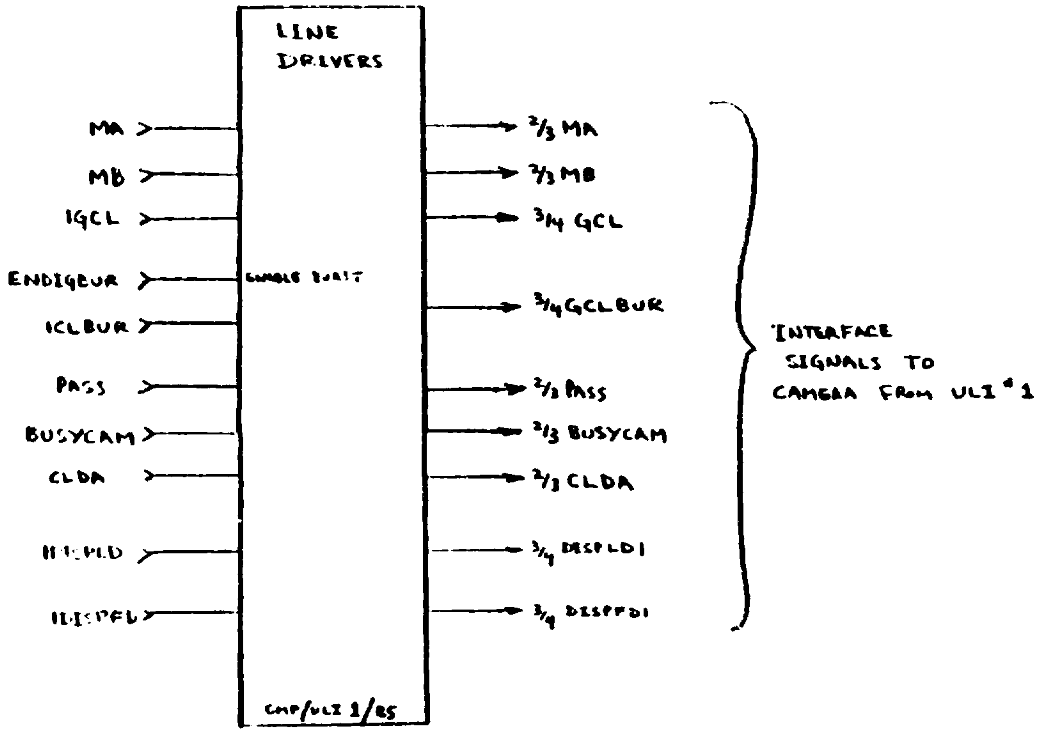


3-6-77

PTS BLOCK DIAGRAM

DIGITIZING ULI #1

Sheet 22

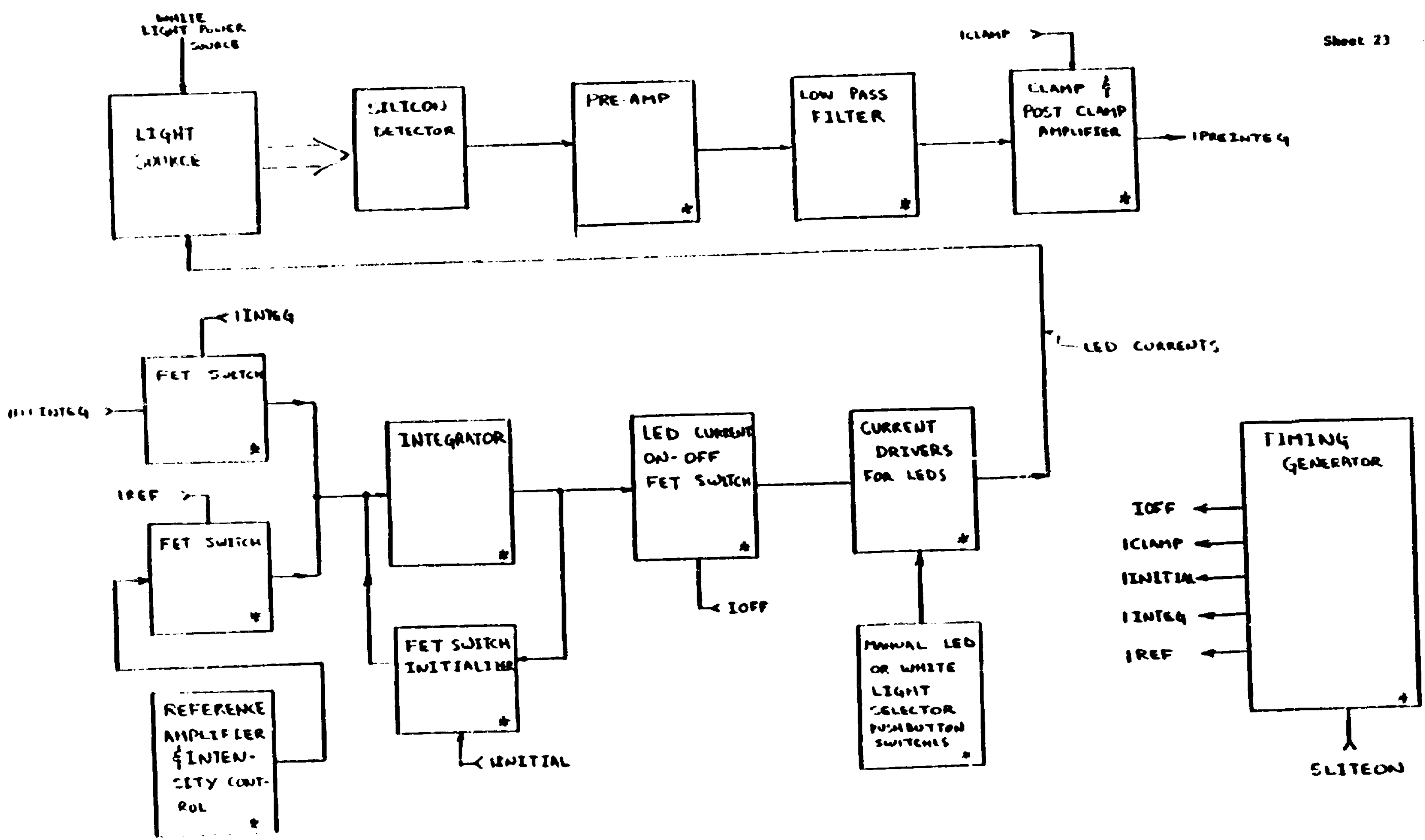


3-8-77

PTS BLOCK DIAGRAM

LIGHT BOX CONTROLLER

Sheet 23



* 2000/2001

3-11-77

SPECIFICATION

LOW LIGHT LEVEL SOURCE

Section 134

This specification describes a low light level source similar to that fabricated by Ball Brothers Research Corporation for SEC testing at BBRC.

1.0 SOURCES

The unit will include four (4) light sources:

(1)	660 ± 30 nm	RED LED
(2)	590 ± 35 nm	YELLOW LED
(3)	565 ± 35 nm	GREEN LED
(4)	White Light	INCADESCENT

2.0 UNIFORMITY

The unit shall exhibit a uniformity of ±2% over a 23 cm by 23 cm[1] test pattern area.

3.0 CUTPUT[2]

The maximum light outputs will exceed the following:

(1)	565 nm	2×10^{-9} watts/cm^2
(2)	590 nm	2×10^{-9} watts/cm^2
(3)	660 nm	4×10^{-9} watts/cm^2
(4)	White Light	1×10^{-6} watts/cm^2

4.0 PHYSICAL DATA

Length	30 in.
Width	11 in.
Height	12 in. (overall)
Center line above mounting surface	TBD

1) 23 cm by 23 cm region of the test pattern area.

2) measured at the diffuser.

4.0 PHYSICAL DATA (Contd.)

Mounting	TBD
Bench Width	TBD

5.0 TEST PATTERN CARRIERS

The unit will be furnished with two (2) test pattern carriers - one (1) each for a 4 in. by 5 in. test pattern and one (1) for 25 cm by 25 cm test pattern.

DATA[1] Uniformity Measurement 1/19/76

YELLOW

	1	2	3	4	5	6	7	8	9
1.	.987	.990	.995	1.009	1.013	1.013	1.013	1.008	.998
2.	.992	1.000	.998	1.013	1.017	1.014	1.013	1.013	.998
3.	.989	.997	1.003	1.007	1.016	1.013	1.001	.990	.990
4.	.989	1.001	1.000	1.008	1.006	1.014	1.008	.994	.989
5.	.989	.997	1.003	1.013	1.016	1.019	1.014	.997	.997
6.	.989	.995	.995	1.006	1.009	1.014	1.005	.994	.992
7.	.990	1.003	.995	1.011	1.017	1.016	1.011	.994	.992
8.	.980	.986	.987	1.008	1.008	1.008	.997	.987	.986
9.	.979	.989	.994	.992	1.000	.992	.992	.982	.986

GREEN

	1	2	3	4	5	6	7	8	9
1.	.986	.990	.995	1.007	1.011	1.013	1.013	.997	.990
2.	.984	.997	1.005	1.015	1.019	1.013	1.013	1.005	.984
3.	.990	1.001	1.001	1.007	1.007	1.007	1.003	1.001	.999
4.	.986	1.001	.993	1.003	1.003	1.001	1.005	.995	.988
5.	.986	.997	1.007	1.009	1.009	1.007	1.001	1.005	.993
6.	.988	1.001	1.003	1.003	1.013	1.009	1.009	1.013	.993
7.	.988	1.001	.997	1.009	1.015	1.013	1.013	1.007	.997
8.	.982	.995	.997	1.003	1.005	1.003	.995	.995	.990
9.	.976	.986	.995	1.005	1.001	.997	.993	.993	.978

OUTPUT

Data Taken With A UDT Radiometer, Type 11A, # 80029, AT DIFFUSER 1/19/76

GREEN	-	12.9 n W/cm^2	@ 100 ma
RED	-	605 nW/cm^2	@ 100 ma
YELLOW	-	16.9 nW/cm^2	@ 100 ma
INCADESCENT	-	11 $\mu W/cm^2$	@ 6.3 V

Note: For improved legibility, the above data was retyped from the original Ball Brothers Corp. data sheet.

Refer to page 145 for notes.

Notes

1. The Ball Brothers Corp. supplied data for the Yellow and Green light source (Red and White not available), was calculated as follows. The Pritchard Photometer readings for each data point was divided by the mean value of all the points. The data points correspond to a position in a 9 x 9 inch grid pattern over the format of the diffuser. The column headings (1 to 9) represent grid position numbers at the diffuser (9 inch by 9 inch pattern).
   Readings were taken with a Pritchard Photometer** at a distance of 4 feet from the diffuser. The photometer acceptance spot size at the diffuser was .28 inches.

* The actual relationship between uniformity of optical intensity and operating current of the LED's has not been measured in this equipment. However, the normal relationship between optical output and operating current for the type of LED used is linear, that is, the optical output is simply proportional to operating current. Therefore, no significant interaction between operating current and uniformity is expected.

* Manufacturer's data (OPCOA LED type LSL) indicates the relationship of current to intensity is normally linear for the Yellow and Green LED. Intensity of the Red LED begins to decrease as the current is increased above 50 ma.

** Model 1980-CD, No. C531.

Section 135 Sensor W 25 Test Report

In this section an abridged discussion is given on the results of the acceptance tests performed on Westinghouse sensor No. 25 (W 25, No. 77-08-947). A full discussion of the test results and general procedures will be given in the final report for the GSFC NAS5-23387.

Table 131 gives the test log for W 25. For each file (frame) digitized, it lists the date, time, PUO tape number, contents of the frame, lines and pixels digitized, the prepare cycle used, the digitizing mode (normal implies 25 μ pixels, burst mode implies 3.1 μ pixels), video bandwidth, the gain applied before A/D conversion, the preamp used, and the operating mode of the beam (pulsed or normal). The A/D conversion is 2 count/mv = 2 count/pa for this test. A more detailed description of test procedures and results may be found in the final report.

Target Response and Uniformity Tests

A contour map of the photometric test pattern appears in Figure 131. (10 contours, zero subtracted 16 x 16 pixel averages). Sample results for the photorun are shown in Figures 132 to 136. The plot title includes the number of the patch (see Figure 111). Comparison patches to obtain stray light levels are also defined (even numbered) but do not affect the plots given here. Zero levels are subtracted before plotting these transfer curves, using the average zero level before and after each run. (Problems with non-repeatable zero levels seem to affect some exposures). The measured signal level (tube counts: 2ct = 1pa = 1mv) is plotted as ordinate. The abscissa is the exposure in photoelectrons, determined by using the photocathode as a photodiode. Current for the light level used in the test was measured with a Keithley electrometer. Each large symbol is the measured mean response for a 50 x 50 pixel patch at a given exposure. The brackets on each

TABLE 131 : TEST LOG TUBE W25 (PUO 124).

DATE	TIME††	TAPE	FILE	CONTENTS	LINES	PIXELS	PREP. CYCLE	DIG.* MODE	BAND-WIDTH	GAIN	PREAMP	BEAM**
3/22/77	9:36	PTS005	1	Photo Run, Ph R, Exp.1. 0^s.	1-2048	1-2048	1	N	40 KHz	1 mv/pa	Narrow	N
3/22/77	10:00	PTS005	2	Ph Rn. Exp. 2. 16^s, ND† = 1.2 Green lights, 4.5, lens f/8 (for all subsequent PhRn exp.)								
3/22/77	10:10	PTS005	3	Ph Rn, Exp. 3 32^s, ND 1.2								
3/22/77	10:26	PTS006	1	Ph Rn, Exp.4. 64^s, ND 1.2								
3/22/77	10:39	PTS006	2	Ph Rn, Exp. 5. 128^s, ND 1.2								
3/22/77	10:51	PTS006	3	Ph Rn, Exp. 6. 256^s, ND 1.2								
3/22/77	11:04	PTS007	1	Ph Rn, Exp. 7. 40^s, ND 0.0								
3/22/77	11:16	PTS007	2	Ph Rn, Exp. 8. 80^s, ND 0.0								
3/22/77	11:26	PTS007	3	Ph Rn, Exp. 9. 160^s, ND 0.0								
3/22/77	11:35	PTS008	1	Ph Rn, Exp. 10. 0.0^s								
3/22/77	11:46	PTS008	2	Ph Rn, Exp. 10. 0.0^s								
3/22/77	11:53	PTS008	3	Ph Rn, Exp. 12. 16^s, ND 1.2								
3/22/77	12:52	PTS009	1	Ph Rn, Exp. 13. 32^s, ND 1.2								

* N = Normal 25 μ pixels
B = Burst 3.11 μ pixels

†† 8:00-12:00 is AM
12:00-17:00 is PM

† Neutral density

** N = Normal P = Pulsed

TABLE 131 : TEST LOG TUBE W25 (PUO 124).

DATE	TIME	TAPE	FILE	CONTENTS	LINES	PIXELS	PREP. CYCLE	DIG. MODE	BAND-WIDTH	GAIN	PREAMP	BEAM
3/22/77	13:00	PTS009	2	PhRn Exp 14 64^s, ND1.2	1-2048	1-2048	A	N	40KHz	1 mu/pa	Narrow	N
3/22/77	13:09	PTS009	3	PhRn Exp 15 128^s ND 1.2								
3/22/77	13:25	PTS010	1	PhRn Exp 16 256^s ND 1.2								
3/22/77	13:32	PTS010	2	PhRn Exp 17 40^s, ND 0.0								
3/22/77	13:40	PTS010	3	PhRn Exp 18 80^s, ND 0.0								
3/22/77	13:49	PTS011	1	PhRn Exp 19 160^s- ND 0.0								
3/22/77	13:56	PTS011	2	PhRn Exp 10 $0^s.0$								
3/22/77	15:47	PTS011	3	Chile Test Pattern 80^s; Green Lights, 4.5								
3/23/77	14:26	EDEN2	1	Image Section Test References (25^oK)								
3/23/77	15:29	EDEN2	2	Image Section Test References (-20^oK)								
3/23/77	16:07	EDEN2	3	Image Section Background 30^m Integration								
3/24/77	08:37	PTS012	1	Target Store Test 16 hr. integration								
3/24/77	10:15	PTS012	2	Target Store Test Ref-2^s EXP, Readout Immediately White Light,125mA Chile Test Pattern								

TABLE 131 : TEST LOG TUBE_W25 (PUO 124).

DATE	TIME	TAPE	FILE	CONTENTS	LINES	PIXELS	PREP. CYCLE	DIG. MODE	BAND-WIDTH	GAIN	PREAMP	BEAM
3/24/77	15:50	PTS012	3	Target Store 2^s Exp, White Light, 120 mA; hold for 120^m before readout Chile Test Pattern	1-2048	1-2048	A	N	40	1 mu/pa	Narrow	N
3/24/77		PTS013	1	Image Section Reference								
3/24/77		PTS013	2	Image Section Background (-20°C) Overnight (Temperature control failed, Target nearly filled with ISB at Room T)								
3/25/77		PTS013	3	Zero exp (15^s of PC on)								
3/29/77	9:55	PTS014	1	Noise Pattern Test 1.5^s Exp, White Light, 5V (Beam in Best Focus) Flat Field Exposure								
3/24/77	10:10	PTS014	2	Noise Pattern Test Same as File 1								
3.29/77	11:54	PTS014	3	Noise Pattern Test Same as File 1								

TUBE 25,PTS011,F1,L&P 1-2048

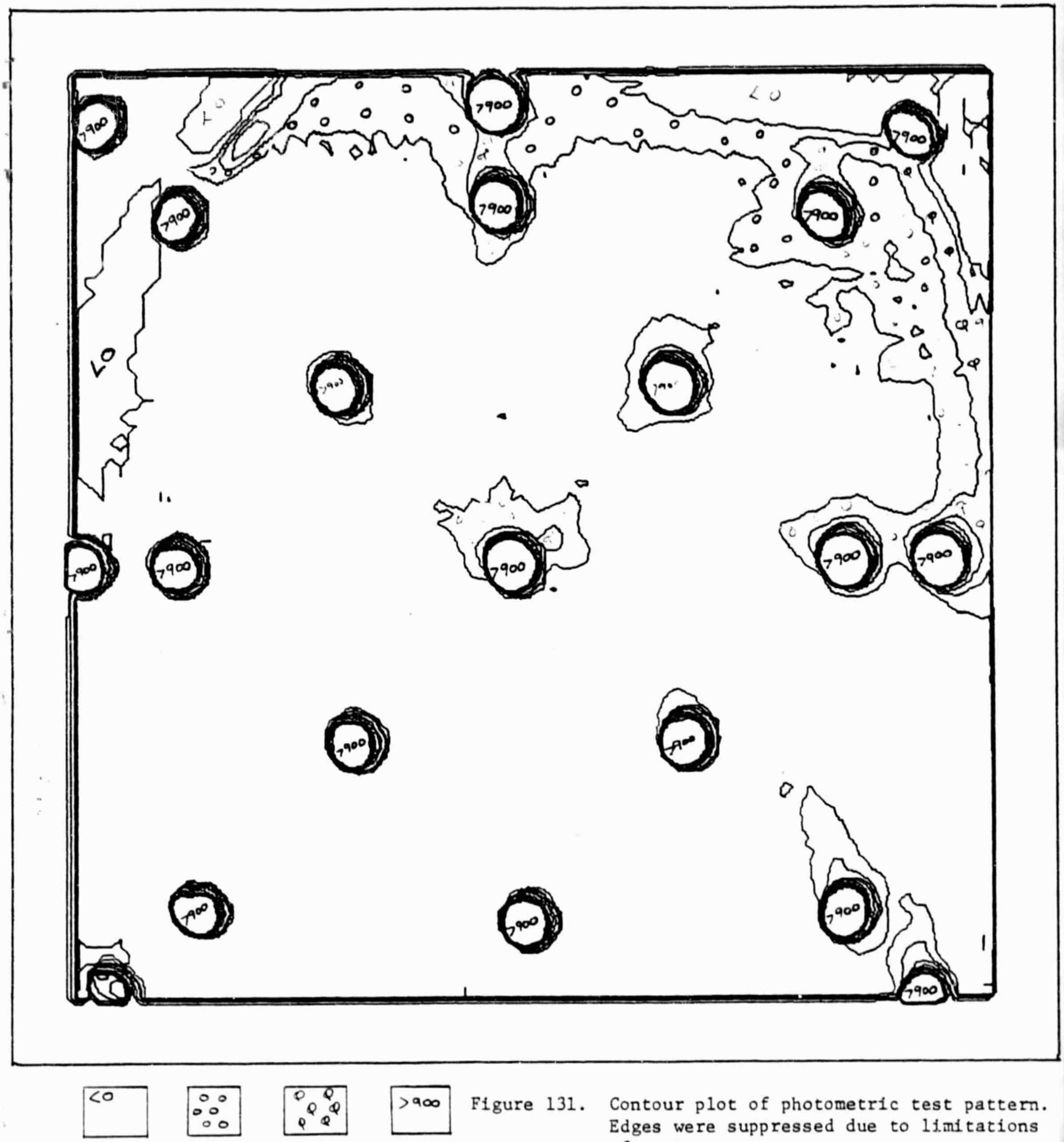


Figure 131. Contour plot of photometric test pattern. Edges were suppressed due to limitations of contour program.

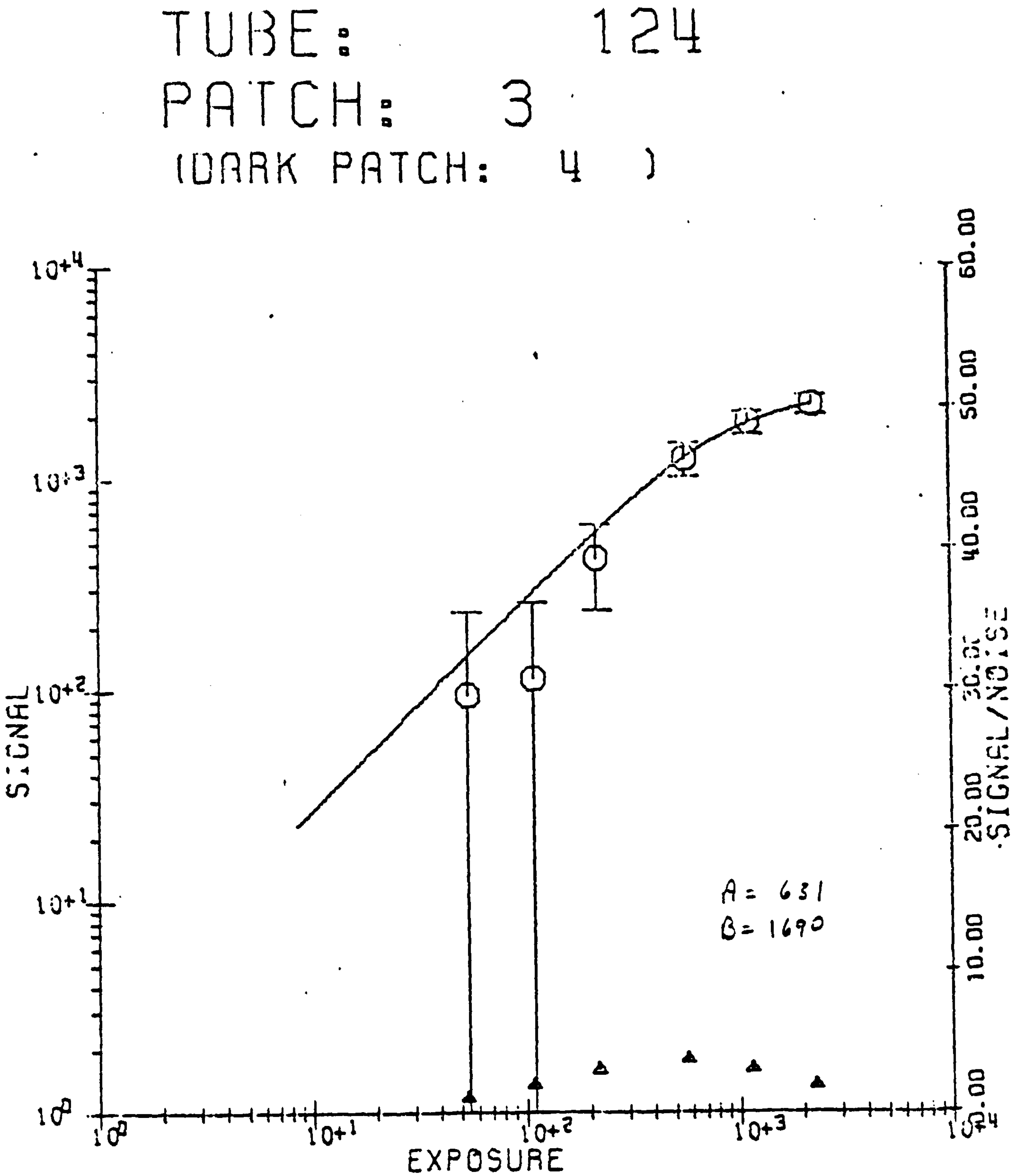


Figure 132. Transfer curves. Symbols are explained in the text.

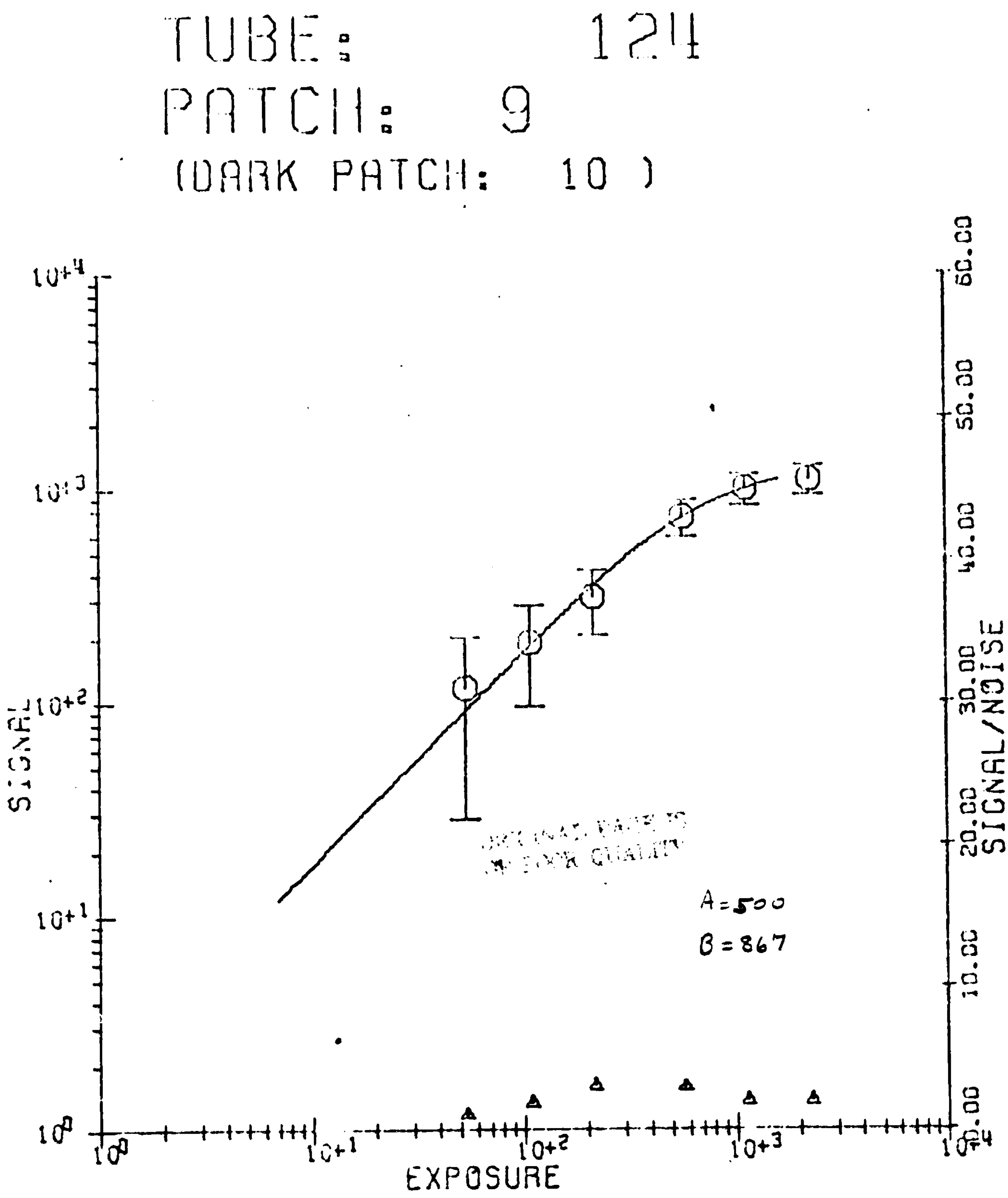


Figure 133. Transfer curves. Symbols are explained in the text.

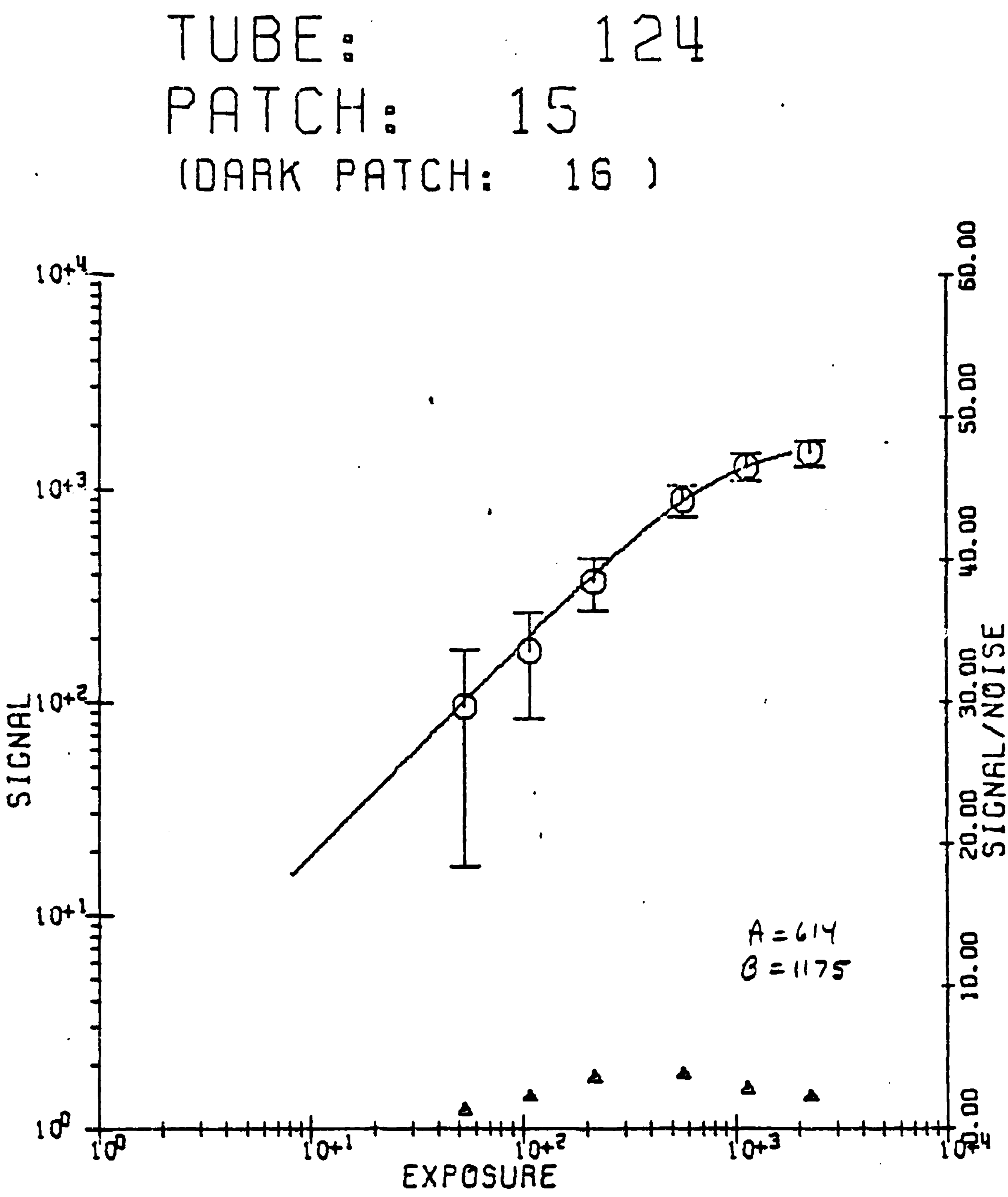


Figure 134. Transfer curves. Symbols are explained in the text.

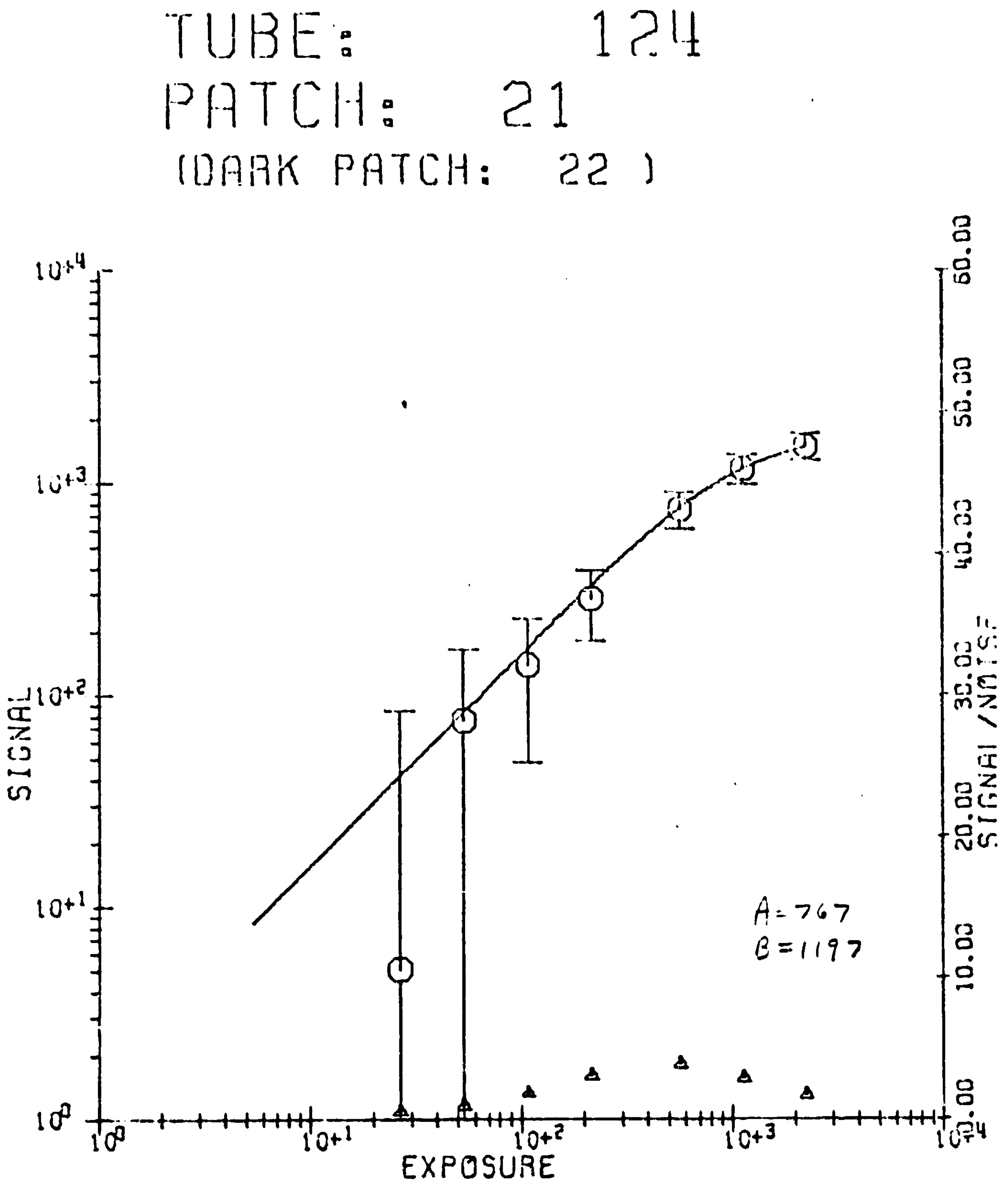


Figure 135. Transfer curves. Symbols are explained in the text.

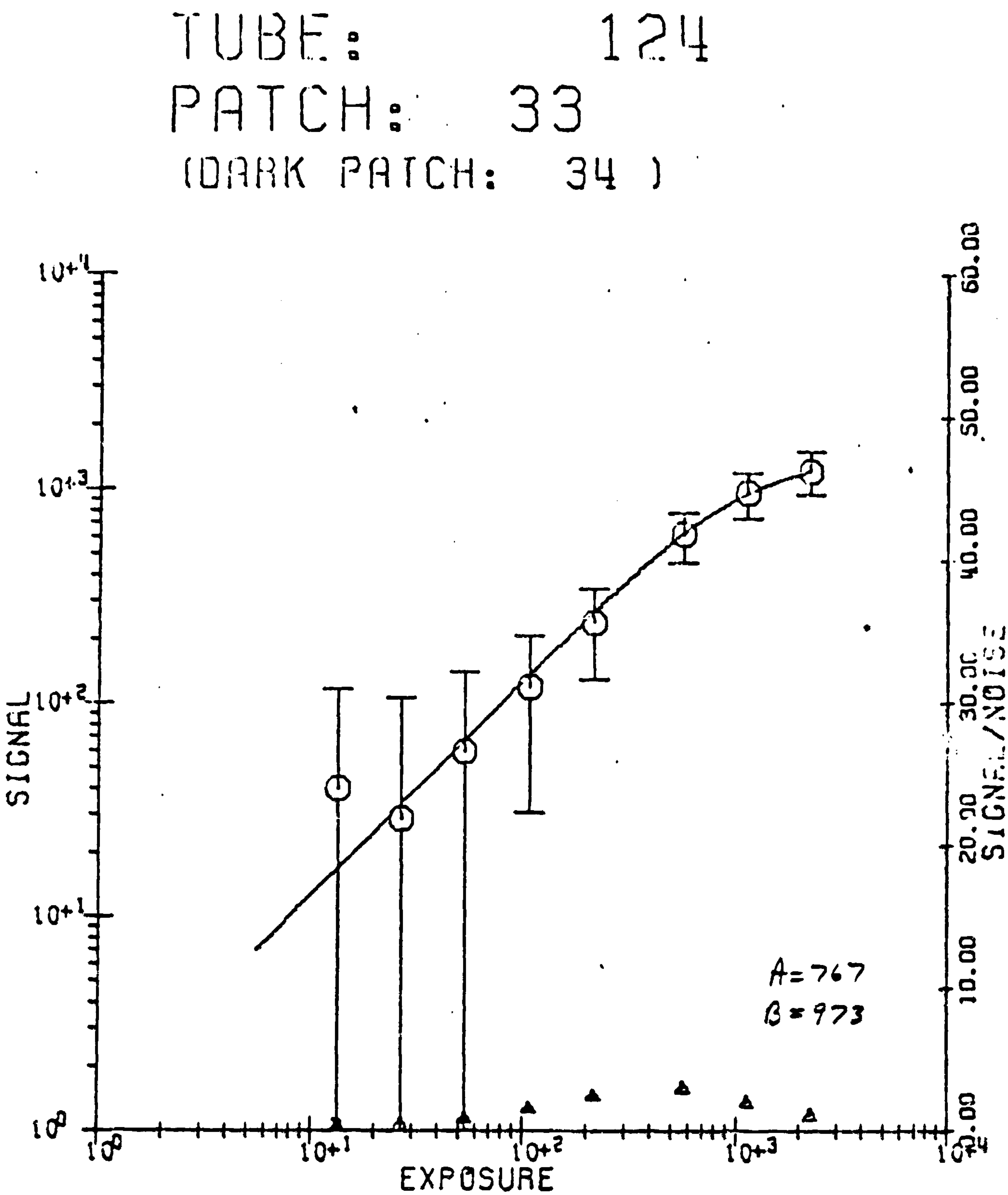


Figure 136. Transfer curves. Symbols are explained in the text.

point show the amplitude of the RMS errors for the 2500 - 25 μ pixels within each patch. This measured error includes effects of photon noise, fixed pattern noise, and beam-target interaction oscillations. Target pinholes and large defects are not included, since all points which deviate by more than 5σ are rejected before final statistics are derived. Data points at the top of the curve have unexpectedly small errors due to electronic clipping: in subsequent tests, a conversion of 1ct = 1 pa was used to eliminate this problem.

A solid line fitted through the data points in a least squares manner is of the form EXPOSURE = A TAN (TUBE RESPONSE)/$_B$. The constants A and B are written on each plot. B is an approximate measure of saturation or capacity. Tube gain is proportional to B/$_A$. Triangles at the bottom of each plot (right hand scale has correct units) show the true signal-to-noise ratio after calibration for 25 μ pixels. Used as a 50 μ sensor, these values would be higher by a factor of 2 (next paragraph). Removal of fixed pattern would raise the signal-to-noise by a factor of 1.4 (see Fixed Pattern Noise).

To evaluate various sources of noise, two tests were performed. The first is to compare the ratio (δ25/2)/δ50. (δ25 = RMS error in 25 μ pixel evaluation). A pixel-to-pixel oscillation induced during readout is present if this ratio is greater than 1, since averaging 50μ x 50μ should reduce random errors by a factor of 2. For Sensor W 25, the average for the above ratio is about 1, indicating that there is little oscillation from pixel-to-pixel. The sensor behaves as if each pixel were uncorrelated with the next.

Fixed Pattern Noise

Evaluation was made by searching two pictures for the same pattern at several locations on the tube. One patch for one frame was shifted with

respect to the same patch of a separate frame (identical exposure) by ± 5 pixels and ± 5 lines. At each shift, an autocorrelation analysis was done. A fixed pattern is present if for one particular shift, a higher correlation coefficient is obtained than for all other shifts (121 coefficients derived altogether). For Sensor W 40, the study was done for File 1 of PTS 007 and File 2 of PTS010, both 40^s exposures. The fixed pattern for 21 patches (see Figure 111) were easily identified and the shifts needed to make the pattern fit were 0 or ± 1 pixel (different from patch to patch). To see if the pattern would be removed in a subtraction process, one frame was subtracted from the other, patch by patch with appropriate shift. An RMS analysis was done on the subtracted image. If only random noise existed, the noise in the differenced frame for a given patch would be higher by $\sqrt{2}$ than the RMS error for that patch in a single frame. The average ratio $\frac{\delta \text{ (differenced frame)}}{\delta \text{ (single frame)}} = 0.9$ for all 21 patches. For no patch was the ratio as large as $\sqrt{2}$. The fixed pattern can clearly be removed, with consequent increase in the signal-to-noise values.

A flat field exposure was plotted in contour form Figure 137. A zero frame has been subtracted. As for Figure 131, 10 contours are used, and 16 x 16 pixel averages were used in forming the map. The units are tube counts (2 cts = 1 pa).

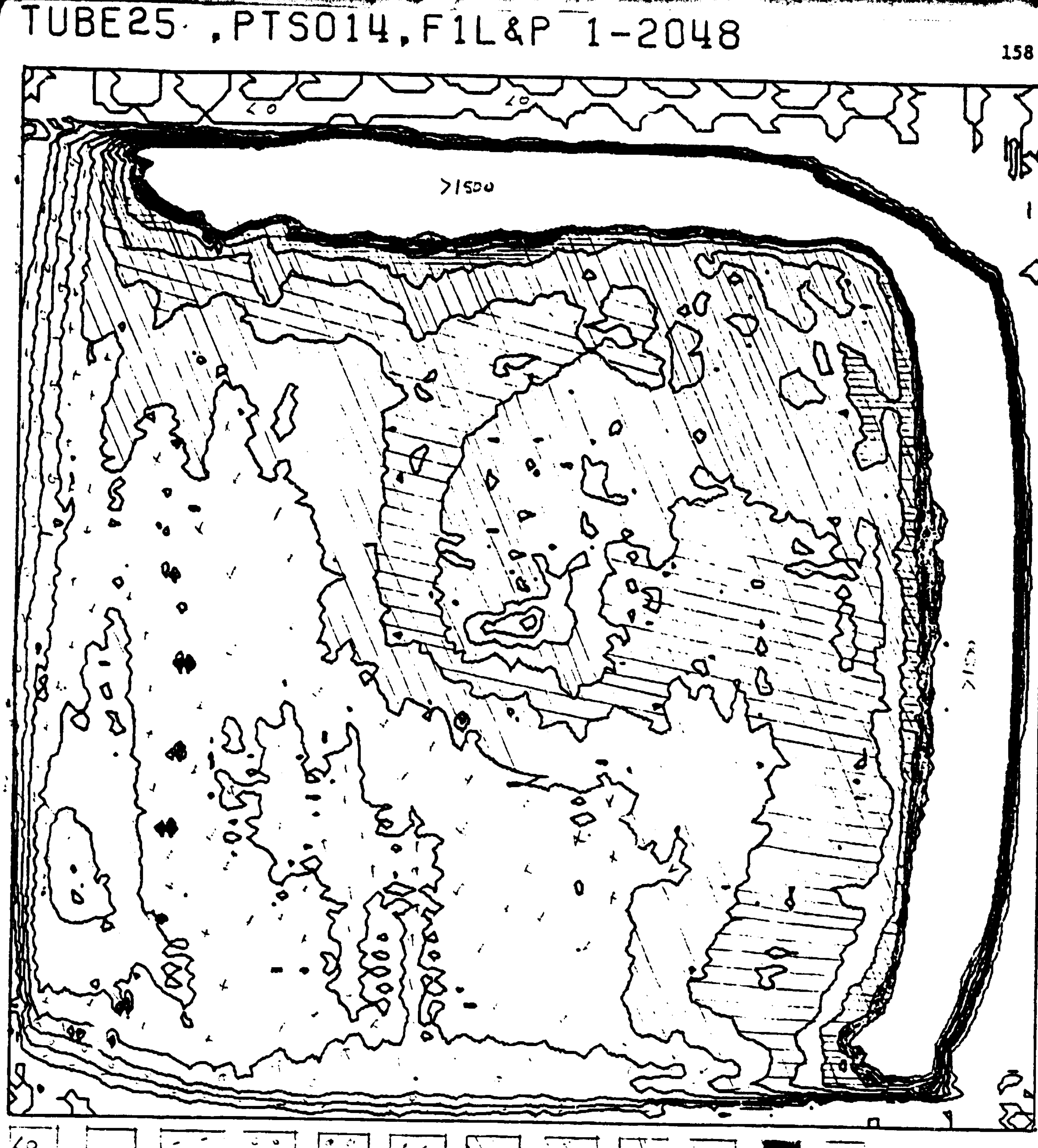


Figure 137. Contour map showing degree of uniformity of a flat field exposure. Units are tube counts (2 cts = 1 pa).

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Image Section Background

Figure 138 shows a contour plot (0 subtracted) of the background in 30 minutes at -20°C (-10°C photocathode temperature). Mean background is 0-4 pe/pixel/min. The contour plot is similar to those shown previously in format (10 contours, zero subtracted, 16 x 16 averages).

Image Store

A comparison of data from identical lines and identical exposures is shown in Figure 139. Each plotted point is an average of four TV lines x 1 TV pixel. The three bottom lines are from a frame readout immediately after it was digitized. The top three lines are from a frame that was stored for two hours before readout. Some degradation is apparent.

Resolution

The test chart used for data in the figures which show storage results was a 35 mm tube test pattern. The pattern used for subsequent 70 mm tests was not ready At the cathode, the pattern projects to blocks containing 55 pixels at 2.1 lp/mm, 64 pixels at 4.3 lp/mm, 69 pixels at 8.6 lp/mm and 46 pixels of white light. The block is surrounded by a 65 pixel wide black border. A white line runs between the black borders of adjacent blocks. From the reference data for storage tests, the modulation at the highest frequency (8.6 lp/mm) is over 50% for the center, but near the edges and top it degrades to 30%. Resolution is poor for this sensor.

Figure 138. Image section background map at -20° in 30 min. A zero frame was subtracted. Units are tube counts (2 cts = 1 pa).

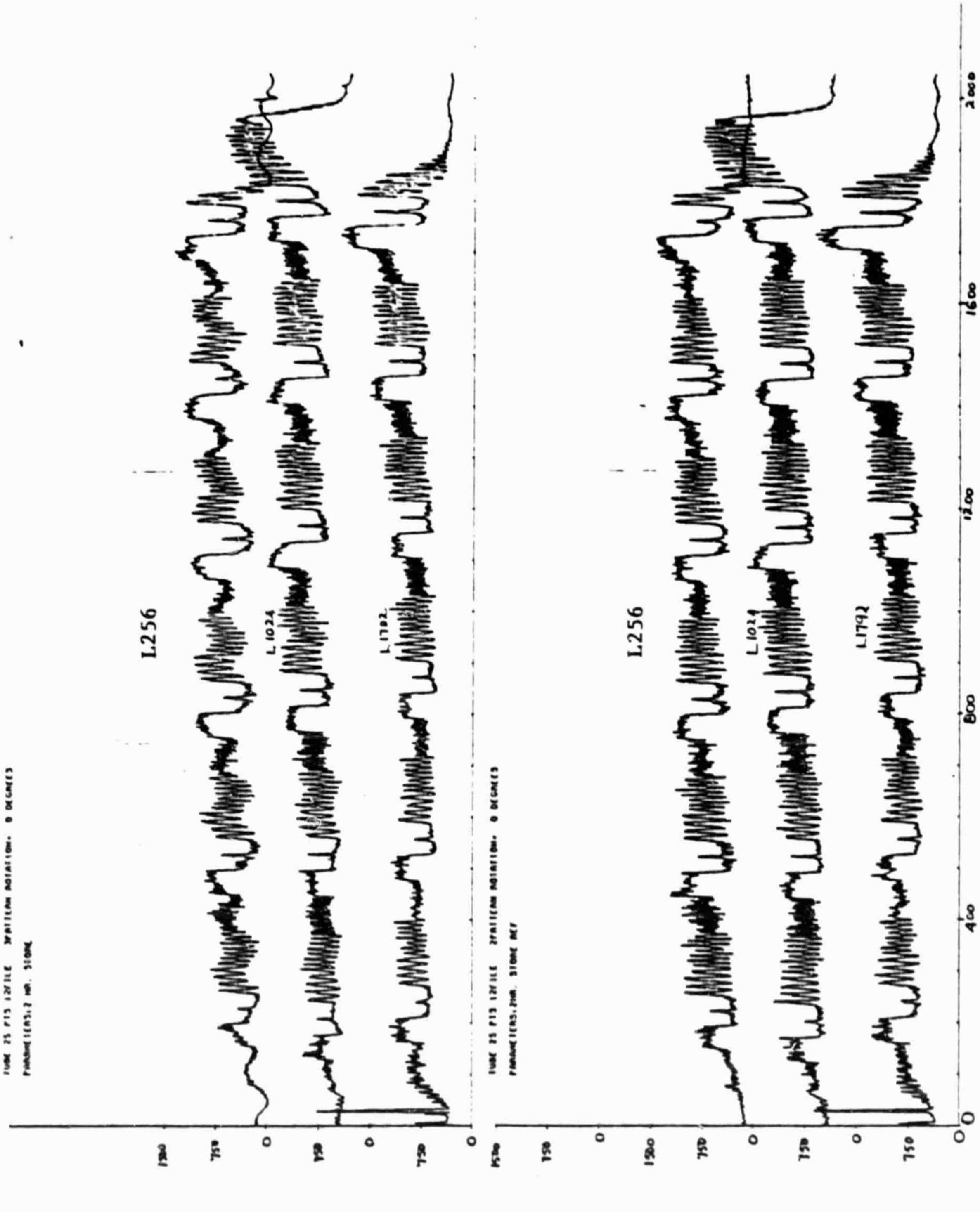

Figure 139. Line plots for TV lines 256, 1024, and 1792. Each point is an average of 1 pixel x 4 lines. Top three lines are from a frame stored two hours. The bottom three lines are for an identical exposure stored only a few seconds.

Distortion

The distortion due to the 70 mm tubes' optics may be judged by examining Figure 140, a picture of the test chart taken with the tube. All lines are purely horizontal or vertical at the pattern, and deviations from orthogonal lines are due to internal tube optics.

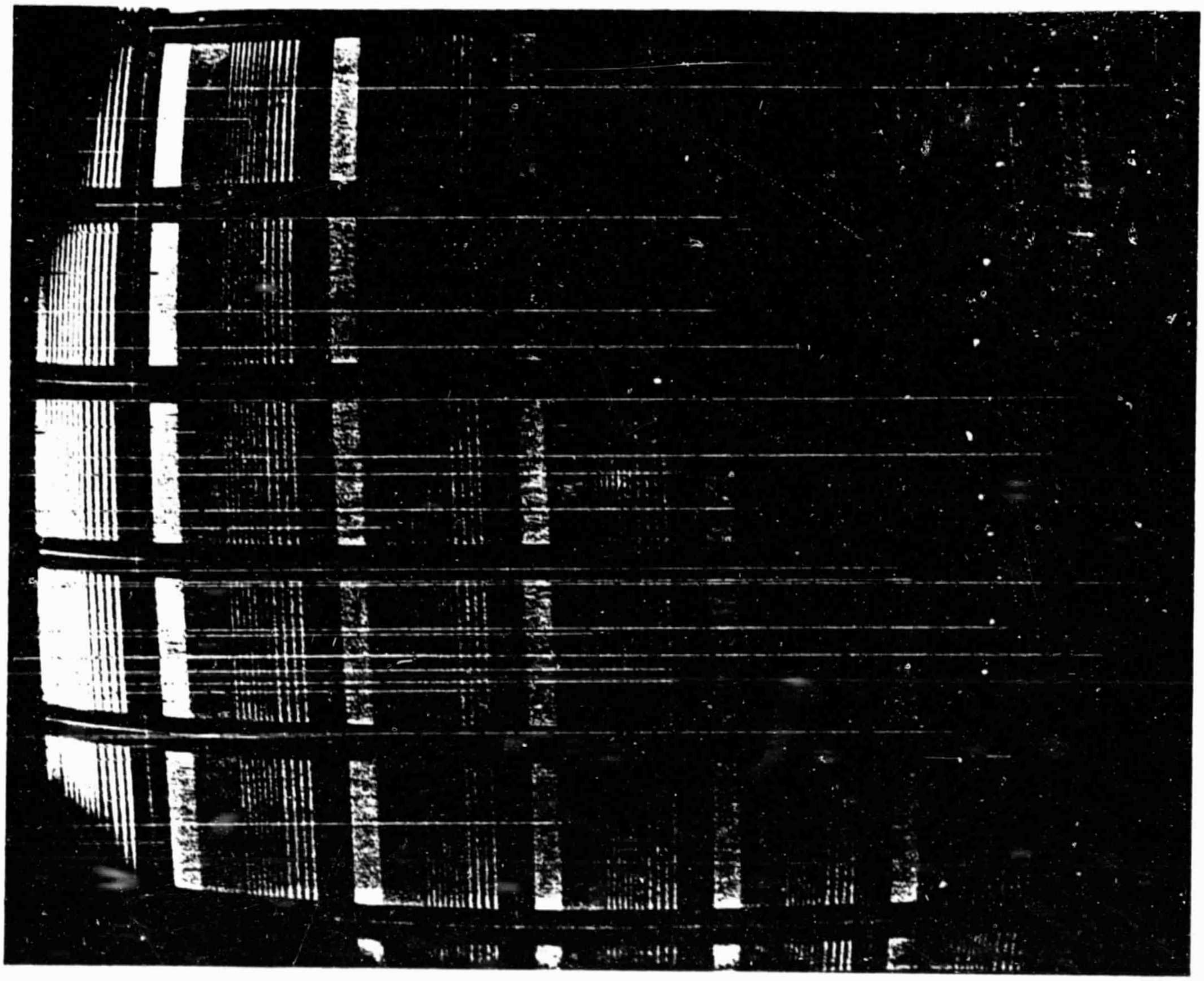

Figure 140 - Test chart exposure used to examine distortion caused by sensor's optics (W25). White horizontal lines are an artifact of the apparatus used to make film negatives from computer tape. Top 3 to 5% clipped during photographic production.

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